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A WELCOME INNOVATION.

WE are much pleased to see that the Institution of Electrical Engineers is at last making quite an innovation. We refer to the Institution dinner, which is arranged to take place on the 4th November, and which it is to be hoped will become a recognised feature in future years. We have often felt that the Institution was sadly wanting in the means for bringing its members freed from the trammels of papers and discussions together now and again. Certainly the *habitués* of the famous edifice in Great George Street could, if they felt so inclined, regale themselves on tea and coffee, and indulge in friendly chatter after the meetings had been dissolved; those who cared for something more substantial with their table-talk had the option of becoming members of the Dynamicable Society now, we fear, defunct; and latterly, the Electro-Harmonic Society has done much to bring members together to enjoy a few hours of relaxation from labours which are by no means easy. But all these do not meet the want which many of us have felt existed in the records of the Institution. An annual dinner is an important factor in the inner working of all well-regulated societies, and we congratulate Mr. Webb on having carried the matter through.

The public at large gains more information of the greatness of the Institution of Civil Engineers, and of the splendid engineering achievements of its prominent members, through the medium of its annual dinner than in any other way. The importance of this yearly gathering is evidenced the next day in the daily Press by the publicity given to the speeches of its President, the orations of eminent statesmen, and the remarks of the leading lights of the scientific, literary, and artistic world, the army, and the navy. The Institution is honoured by the presence of the representatives of all the world's intellect, and these, again, are honoured by becoming the favoured recipients of the Civil Engineers' gracious hospitality. Why should it not be so with the Institution of Electrical Engineers, which is now entering upon what we trust may prove to be a great career? Hitherto the more recent electrical industries may be said to have been in more or less an experimental stage from which they are now emerging with every prospect of taking place among the most important factors in the future history of this country. The Institution is now the representative body of all classes of electrical engineering, and though it may not rival that of the Civil Engineers in the extent of its operations, it should eventually prove to be a good second. We are glad, then, to see that its annual dinner has at last sprung into existence, and we trust that the initiatory meeting may be so successful that all doubts as to its continuance may be set aside. Nothing but good can come of such genial gatherings, for friendships already made may yearly be more firmly cemented under the perfect good fellowship which must necessarily exist among the members of the institution. "Electricity is Life," and this annual festival will be not the least important item in the existence of the electrical engineer to make life worth living, for of its sweets until now he has had but few.

TEACHERS AND STUDENTS.

PROFESSOR PERRY'S address as president of the Junior Engineering Society, which we see published in the *Contract Journal*, is very interesting to young students and is well worthy their consideration, for it is eminently practical. The gist of the professor's remarks may be said to lie in the statement that an electrician must be a good mechanical engineer, and that applied electricity is merely a branch of mechanical engineering. A splendid practical example of this kind of teaching can be seen at the Sardinia Street Works of the Metropolitan Electric Supply Company, where the mechanical engineering is very perfect, the electrician's portion of the installation being decidedly a secondary consideration. Ten years hence, Prof. Perry believes that the electrician

will be of as much importance as the steam-engine engineer, and that no man having a right to call himself an engineer will be without a good working knowledge of electricity. This last statement is, we think, going rather beyond the mark, for a man may be an eminent engineer even in ten years from the present time, and yet be absolutely ignorant of electrical data. There have been many important works accomplished previous to our day without the aid of electricity, and much will be done in the future, so we cannot help thinking that the president of the Junior Engineering Society has unintentionally misrepresented his actual meaning. Indeed, he says in his address, we are all specialists now; we can then only ask how much more will it be necessary to be specialists in the not far distant future?

When the Professor goes in for historical facts he becomes rather wild in his utterances. For instance, he says:—"In that year (1866) Varley, who was Thomson's partner, and others, made independently one of the grandest discoveries of the century, and presently a machine was in use which excited its own field magnets, the type of all dynamos ever since." Now, Prof. Perry knows perfectly well that the Varley he refers to is Cromwell Varley, and that S. A. Varley who patented the machine which forms "the type of all dynamos ever since," was never a partner of Thomson's. Mr. Perry is not the first public speaker who has overshadowed S. A. Varley's work by bringing into the foreground his brilliant brother; but is it not time that those who are supposed to instruct our embryo scientists and engineers should simply state plain truths, and not embellish their orations with figures of speech which are absolutely misguiding? Surely it is not a difficult task for men in high positions to be generous, and to give credit to whom it is due?

With this one exception we do not think there is anything to cavil at in the address, which is full of good advice to the youthful aspirant for fame. We should be glad to see more of the kindly feeling which evidently animates Prof. Perry when talking to his young friends, for he must at once command the sympathy of his audience, and when this hold has once been gained upon their feelings the rest is plain sailing when an address is couched in the plain and practical language which characterises that of the President of the Junior Engineering Society.

Money must be reduced to the direst extremity when compelled to use such an argument as the following in condemnation of the electric light:—"Two noteworthy references to the respective merits of gas and electric lighting were made in the speeches of Sir Robert Rawlinson and Mr. George Livesey at the general meeting of the Commercial Gas Company on Friday last week. Speaking of the practical difficulty of managing the intense light of the electric arc, so as to be useful for ordinary purposes, Sir Robert stated that at the Forth Bridge, which had been advanced by night work, the electric lighting provided for this purpose worked out to an allowance of 700 candles per man employed on the works. This is a truly startling figure. Of course, a man does not want 700 candles, or anything like this glare of light, to enable him to work, or find his way about scaffolding. This represents so much waste of lighting energy; and the lesson of this statement may be commended to the wiseacres who make out that electric arc lamps for street lighting, for example, are cheaper than gas, because, although costing more money, they yield so much more nominal intensity of light. So much the worse, it may be replied; for who wants hundreds of candles to light him across a road? Moreover, the intense shadows thrown by the arc light render the crossing of crowded streets far more dangerous than when lighted by gas." If our financial contemporary will only go so far into figures as to give us comparative estimates of the outlay which would have been entailed in supplying the Forth Bridge works with the rival illuminants, the reason for the adoption of the electric light may make itself apparent. *Money* is at liberty to say what it thinks proper about men not wanting a light of 700 candle-power to do their work at night or so find their way about a scaffold—the latter indeed might be accomplished in an emergency by means of an ordinary lucifer match—but no one in his senses would deny that the nearer we can approach to daylight by artificial means, so much the better for the progress of the work. Gas, unfortunately, unless at a much higher cost, cannot give us this precious boon.

THE New York *Tribune* of September 19th contains the following amusing skit under the heading of "Mistakes about America." After briefly informing its readers of the remarks made by Mr. Preece at the B.A. meeting, to the effect that the dangers of shocks from wires carrying currents of high tension had been shown to be all nonsense, the writer goes on to say that it is understood that the electrician to the Post Office is engaged upon a work designed to correct some other misapprehensions among his fellow-countrymen with regard to the land of the free. Advance proofs of this valuable publication are understood to contain, among other interesting items, the following:—"The sensational news which has reached these shores regarding alleged disasters at the recent buffalo hunt on Broadway we are authoritatively informed is entirely erroneous. It is several months since the untamed bison has been permitted to roam at large on that crowded thoroughfare. Fifth Ave, and Central Park are in reality the only remaining places where the trans-Atlantic Nimrod can pursue this exhilarating sport within the precincts of New York itself. The Benevolent Order of Buffaloes is an association whose existence is due to this fact. Its headquarters are at the City Hall. William Waldorf Astor, otherwise known as Buffalo Bill, is its president." "The absurd rumours afloat here during the past week concerning the damage by a recent cyclone at Coney Island are absolutely without foundation. Coney Island, as every schoolboy knows, is the ground on which New York City is situated. It is not a peninsula, as Lord Brassey recently asserted, but is likely to become one, the dumping of ashes by outgoing steamers to Liverpool having already begun to choke up the Harlem River, through which they pass. The reported washing away of bath houses is evidently an allusion to Castle Garden and the Barge Office, where the steerage passengers from Europe are obliged by law to wash themselves before landing."

MONTREAL is much perturbed with its electric lighting. There are 800 arc lights in the city, but the distribution over the various districts is said to be neither fair, just nor judicious. The only way out of the difficulty is to put up 125 more arcs, and then Montreal will be the best lighted town on the American Continent. There are, however, some signs of trouble with the rapacious gas company, which is offering to undercut the prices for the electric lamps, but we anticipate that the matter will end in a way favourable to electricity.

A WRITER in the *County Gentleman* begs to inform theatrical managers that electricity does not heat theatres. It appears he was present at the revival of the "Profligate" and suffered great inconvenience from draughts. While not denying the non-heating effects of the electric light, we might point out that no heating apparatus of any description would obviate the ill effects of draughts. Free a theatre from these and no heating apparatus whatever is required.

OUR contemporary, *Money*, is of opinion that an advertisement which has recently appeared in the *Daily News*, for writers on the commercial aspects of electric lighting, is the last despairing cry of a lost cause. We fail to see the reasonableness of such a conclusion. It does not follow because writers are required on a subject of which so little is known that that subject is in the last stages of decay. Then again, we do not see exactly why electric companies should require hack writers as *Money* seems to think. It appears more reasonable to suppose that non-technical journals are finding it necessary to pay attention to what is undoubtedly a great power; at any rate our contemporary cannot deny the fact that writers possessing the requisite knowledge are wanted badly on even a few financial journals.

A COMPANY of gentlemen interested in the problem of imparting initial mechanical motion to vehicles after temporary stoppages assembled at the Manchester Carriage Company's Works, Openshaw, last Friday afternoon, to witness a trial of an invention for this purpose, patented by "The Brake and Starter Company, Limited," and which practical experts are satisfied will supply what has been desired for many years —viz., an effective method of storing power hitherto wasted, either in stopping a tramcar or other vehicle with revolving axles, when the brake is applied, and utilising that power for restarting the vehicle when desired. It is calculated that there is as much power required to start the dead weight of a car, however driven, as would suffice to run at least a quarter of a mile. Amongst those present was Mr. Arthur Shippey, electrical engineer, London. After several trials had been made in the company's premises, a journey was made as far as Audenshaw and back, during which the brake and starter were frequently tested, and gave general satisfaction. After the return journey, when the horses were removed and the gentlemen present had alighted, the brake was released, when the car was propelled a distance of 30 feet. In the evening, at dinner, Mr. Shippey said he had never been so pleased as with the invention put before them that day. In America they had not a brake and starter equal to it. It was a marvellous and ingenious invention, and Manchester ought to be proud of introducing it to the world. It must, indeed, have been a red-letter day in the history of Manchester to have its inventive genius trumpeted abroad by a gentleman possessing Mr. Shippey's influence and weight in the commercial and scientific world.

"THE Boston Board of Fire Underwriters" are having much trouble with the electric light wires. They report that the loss by fire occasioned by electric lights in Boston for the year ending May 30th, 1889, aggregated nearly $60,000, and they have proposed to advance the insurance rates upon risks lighted by electricity. The electric light companies naturally object, and urge that the fault lies with the inspectors appointed by the Board of Underwriters.

THOSE who have studied both old and new science text books can hardly have failed to notice the marked difference in style between the two. The somewhat cramped and uninteresting descriptions of experiments made with philosophical instrument makers' apparatus (generally very expensive) have now largely given way to practical details of apparatus which the student is instructed how to make for himself, thus learning theory and practice together in a style which enables him to grasp both at the same time in a very thorough manner; in fact, paradoxical as it may seem, he learns as it were two trades simultaneously, and conquers each one more thoroughly than would be the case if he spent the whole time on one alone. Formerly, for a professor to be able to handle or teach how to handle a tool would be thought rather out of place, but now all is being changed through the spread of technical education; and although the improvement progresses but slowly the character of the teaching will eventually prevent so many mistakes being made, and, as a consequence, so much money being wasted as has occurred in the past in all branches of mechanical art, and in none more so than in the case of electric lighting installations. The student who is capable of working out the most abstruse mathematical calculation will have to keep in the background unless he is able also to roll up his shirt sleeves and work creditably at the anvil, bench and lathe, and thus know how to make his theoretical knowledge of practical value.

THE dead-lock which has been brought about between the electric lighting companies of New York and its Mayor is a very lamentable occurrence. It is said that public feeling has been roused to a high pitch over the numerous deaths from contact with electric light wires, but, as we have previously pointed out, the change from overhead to underground mains is a matter involving much time, and cannot be instantly accomplished at the sweet will of the gentleman who presides over the destinies of New York. It is stated that until the law disputes between the different companies are settled, that city will have to be lighted by other means. Luckily we are not likely to have such a calamity befall the City of London, so, perhaps, the watching and waiting tactics adopted in this country are preferable to that spirit of enterprise which characterises our neighbours across the water, at least so far as electric lighting is concerned.

THE TELEGRAPH IN WARFARE.

AS already briefly reported in the ELECTRICAL REVIEW, Col. Jelf, late commanding the Telegraph Battalion of the Royal Engineers, in the course of a paper which he read at Aldershot last week, threw light on the subject of telegraphing in warfare. He stated that it was no error to say that two sections of telegraphists could be raised to a war footing, ready to start in 48 hours after the receipt of the order to mobilise. Of course, this meant the nucleus of 200 miles of telegraph There was a great drawback in the organisation of the Telegraphic Department of the Royal Engineers. That defect was that there was no head to the battalion, either as a director of telegraphs or as a lieutenant-colonel commanding. This important appointment had to be made in war time. When a war was declared these telegraph officers were involved in a great responsibility. The anticipation of all requirements was not only the most serious and difficult of duties, but also the surest guarantee of success. It was true that direct communication with home might seriously hamper a general's movements by being at the beck and call of wavering counsels at home. In these days of cheap newspapers, great interest was always taken in the smallest details of a campaign. The fact that the home population now knew day by day exactly what was taking place, and how the army was faring in time of war, added a great deal to the popularity of an expedition, which was highly essential to its being approved of and appreciated by them. Nobody who remembered the blank feeling of insecurity which came over the country after the Isandula disaster, when there was no cable communication with the Cape or field telegraphs to Lord Chelmsford's forces, or the dull sense of uncertainty which prevailed after Herbert Stewart's gallant column started across the desert without a telegraph, could doubt the truth of what he said. It was a fact that whilst the German Kaiser, on his recent inspection at Aldershot was complimenting the troops, he was at the same time communicating his observations to the Empress at Potsdam. The value of the Telegraph Battalion might be better illustrated than it was on field days at Aldershot. He thought the hands of young non-commissioned officers, and even private soldiers, who often, in active service, found themselves in charge of solitary offices, the whole responsibility of which rested on their shoulders, should be strengthened in every possible manner. In many cases these men were involuntarily the repositories of burning secrets, and he should like to make it public that in no one case had a breach of confidence occurred.

Captain Glen (Inns of Court Volunteers) described a light and portable field telegraph, invented by himself, for the purpose of continuing the electrical communication to the units of a force from the terminus of the trunk of the Royal Engineers' line.

A discussion followed, in which Major Beresford said that, owing to there being a great insufficiency of military telegraphists, they had had to employ some 60 civilians. He had often endeavoured to rectify this by employing soldiers, but his attempts had invariably been frustrated by the Treasury. The debate was taken up by several well-known military authorities on telegraphing in warfare, including Gens. Walker, Sir Evelyn Wood, Colonel Hutton, and Major Davidson.

A NEW ERA IN TELEPHONY.*

DURING the past three or four years much has been written and said about long-distance telephoning and the work of the American Telephone and Telegraph Company, of New York. It has been announced that in the experiments carried on by this company a perfect telephone service has been accomplished, either for long or short distances. As the extension of the so-called "long distance" lines has progressed, it has been shown in many of the Eastern cities that these results are accomplished, not only experimentally, but practically, and so reliable and perfect is this telephone service, even at very long distances, that it has become an integral factor in the most important departments of trade and commerce, and as much to be depended upon as mail or railway service.

The steady and gratifying increase in business over the "long-distance" lines has shown that the public will appreciate good and satisfactory telephone service when it is provided, and the demand for this perfected service may be said to have created a new era in telephony.

While some improvements in apparatus have been incident to the new service, the principal factor has been the proper use of metallic circuits in telephone work. By means of metallic circuits properly arranged, all inductive interference from adjacent lines of telephone, telegraph, electric light or power wires, as well as disturbances from atmospheric or earth currents, has been overcome. Circuits have been successfully operated through longer lengths of submarine or underground cables than has heretofore been practicable, and late conferences have provided a standard specification for cable manufacture. Metallic circuit switchboards have been provided, even in large exchanges with the multiple system, and the long distance cabinet instrument has been applied for the convenience of the subscriber. Thus there has been supplied what would seem to constitute all the necessary provisions for the new service. These component parts, however, although essential to it, will not, in themselves, accomplish the desired result.

It has been the experience of the American Telephone and Telegraph Company that grounded circuit methods, as they have been generally practiced in telephony, are not satisfactory when applied to metallic circuits. Many radical changes have been made. The great underlying principle has been found to be that a perfect balance of the two sides of the circuit throughout its entire length is necessary to the best results, and to maintain and preserve this balance requires the closest attention to every detail. In other words, the new service requires, first, proper engineering: and second, a force educated and trained to carry out the plans provided.

As representative of the practices in vogue at the present date, we give in detail the specifications of a local metallic circuit and its usual extensions.

At the subscriber's stations should be placed a long distance cabinet set; this is in the form of a small desk, and is supplied with the usual working parts of a magneto bell, wired with waterproof insulated wire on a grooved base board, so laid out that no two wires cross each other at any point. The telephone hook is provided with platinum contact points. The binding posts are of the double lock nut style, and provide a large bearing surface for the attached wires. The line wires are led to fusible coil arresters, which burn out with a current of one half an ampère, combined with two plate arresters, having an area of about one-half a square inch and insulated from the ground plate by a strip of mica. Underneath the desk a battery box is provided, which is capable of holding three 6 × 8 jars. A push button is placed conveniently, by means of which the subscriber is enabled to cut out the secondary coil of the transmitter, thus lessening the retardation in the circuit, and at the same time removing the microphonic disturbances caused by his own transmitter.

Three cells of an open circuit battery should be generally used on this cabinet set. The internal resistance of each cell of battery should not exceed one-half ohm, and the electromotive force should not decrease over 15 per cent. after the three cells of battery connected in series are short circuited through

* Paper read before the eleventh meeting of the National Telephone Exchange Association of America, by A. S. Hibbard, J. J. Carty, and F. A. Pickernell.

a resistance of 7 ohms for 20 minutes. In cases where the transmitter is to be used for longer periods, it is necessary to use a constant current battery. We find the Fuller battery to give the best results under such conditions.

For the interior office wire, nothing less than copper wire ·0403 inch in diameter, insulated to $\frac{4}{32}$ of an inch, with the best quality of waterproof insulation is to be used, clamped to the wall by wooden cleats if possible.

The wires should enter the building through hard rubber tubes, which are so inclined that no water can leak in. From this point to the roof rubber-covered wire should be used, extending to the overhead conductors, all connections being made with McIntire sleeves or soldered. The line wires should be hard drawn copper, having a diameter of at least ·08 inch, and supported every 125 feet. Copper wire is recommended on account of its low resistance, its low electrostatic capacity, as compared with iron or steel wire of the same conductivity; its low coefficient of self-induction, and especially its durability. There is little depreciation in copper wire after it has been strung, the gases common to large cities having very little action upon it, and its life is very many times greater than that of iron or steel wire, thus rendering it in the end the most economical.

In making joints in hard drawn copper wire the McIntire sleeve should be used.

In building the loop, both sides of the circuit should occupy adjacent pins on either housetop fixtures or on a pole line, thus causing the relative distance of the two sides of the circuit, toward foreign wires, to be the same throughout their course. This is of great importance if the loop is of sufficient length to render transpositions necessary. On exposed housetop fixtures nothing but waterproof insulated wire is to be used. From the cable fixture, leading wires, not less than ·0403 inch in diameter, insulated $\frac{5}{32}$ of an inch with the best quality of waterproof insulation, extended through cleats on the under side of the cross arm to wooden ducts fastened to the back of the cross arms, or through properly constructed cables, should lead to the cable box or tower. The leading wires should be joined to the line wires either by McIntire sleeves or by soldering. Care must be taken not to solder to the line wire between supports, as heating the hard drawn copper anneals it and reduces its tensile strength.

Inclosing the cable terminal we have used a dust and moisture proof iron cable tower, cylindrical in shape, built completely round the pole, and supplied with a suitable platform and railing. A complete description of this tower may be found in the report of the last Cable Conference. If a wooden box is used it should be made of $1\frac{1}{2}$ inch pine, tongued and grooved, having double doors hinged at the top and opening together. Its interior dimensions should be sufficient to give a space ample for placing the cable head, lightning arresters, and bridle wires. The box should be well oiled on its interior and painted thoroughly on the outside before placing in position, the joints being white leaded before the box is put together. The terminal tower or box is to be locked, and it is recommended that a standard padlock be adopted and used for this purpose. In this tower or box the bridle wires are connected to the plate and fusible arresters. To protect the cable against heavy electrical discharges, we provide at the exterior terminal fusible coils and properly constructed plate or pointed lightning arresters. The fusible coil at this point is so designed that it burns out with a current of 1 ampère, thus having twice the carrying capacity of the central office arrester; this protects the cables and prevents a large number of burn-outs at points remote from the office, locating most of them at the office terminal, where they may be quickly repaired. The outside wires extend first to the plate arrester, which discharges the lightning to ground at the cable pole and prevents the burning out of many fusible coils. The ground plates upon the arresters should be connected to moist earth by means of conductors run independently of the cable sheath, and should have three times the conductivity of the line wire. For this purpose, three No. 12 hard drawn copper wires twisted together may be used.

The arresters should be connected to the cable heads by waterproof insulated wire.

The binding posts on the cable terminals should be arranged in pairs, so that the two wires of a pair will be exactly opposite each other horizontally. This form is described in the report of the last Cable Conference. Its advantages are apparent at once. If a form of cable is used not requiring a permanent head, it may be connected directly to the lightning arrester binding posts in the order recommended above. We recommend, especially at the cable head, that nothing but lock-nut binding posts should be used.

The underground cable should extend from the subway to the fixture at which the terminal is placed, through a 3-inch iron pipe. These cables are usually led to and enter the office building in a great mass of ducts. At the point where they enter the office it is of especial importance that each cable should be available for handling at any time. It has been found that a symmetrical method of leading cables from any massed run into two vertical lines, hanging them on cable hooks attached to posts, or to the walls of the building, provides a plan whereby any one cable may be reached as desired. At each angle, or, indeed, at each point at which it is ever expected to reach and handle the cables, some such arrangement should be made. In many of the present large underground systems no provision has been made for this purpose. The cables have been pulled in indiscriminately, and no regular method of attachment has been provided. As a result, in what are purported to be drawing-in and drawing-out underground systems, it is even now becoming very difficult to do the work of drawing in, and wholly impossible to do the work of drawing out specific cables, without interrupting the whole system. This is apparently caused, first, by the very limited area of the underground manholes, and, second, by the failure to provide a comprehensive system, by means of which every one of the underground ducts may be utilised as desired.

In making a recommendation for a central office we are brought into consideration of the larger subject of the telephone building itself. This should be designed especially for the occupation of the operating switchboard and its necessary adjuncts. To that end the building should first of all be fireproof. The operating office should be on the top floor. Provision should be made for leading the underground cables to a shaft of suitable dimensions, extending to a room which should be set apart for the terminals, distributing and testing purposes. Near to this should be a battery and power room of ample dimensions, providing for the generators, motors, main and testing batteries, with the necessary water connections and other appurtenances. The form of the operating room itself would, of course, depend largely upon local conditions. One of the chief requisites should be the anticipated ultimate capacity of the exchange. In general, if it is necessary to deflect the board from a straight line, it is better to have the operators work from the inside of a circle than around the outside, the arrangement being such that all operators are at once within view of the chief operator. The office should be free from elevator shafts or other obstructions, and should not be made a passageway for employés in reaching the roof or any other part of the building.

In view of the specific purposes of the telephone building, we think that, before plans are made for it, the telephone engineer, together with the architect, should definitely lay out the space to be occupied by the different departments which are to be devoted to the business, and especially their relation to the operating room, as it is almost impossible in a building already completed, or having plans laid out independent of this purpose, to arrange a telephone plant to the best advantage.

The underground cables extending to the operating office should be of the well-known Conference standard, No. 18 B. & S. gauge wires, twisted in pairs. At the central office end these cables should extend to a

room just as near the operating office as possible, where they should be headed and connected to fusible arresters which will burn out with a current of half an ampère. From these arresters the circuits should be led by office cables twisted in pairs to the terminals of the distributing board, the opposite terminals of this board leading to the operating switchboard. This distributing board should be made in such form that wires may be led at any time from any point on the line terminals to any desired number on the switchboard terminals, it being so arranged that even when fully occupied all distributing wires are available for handling as desired. The distributing wires should be rubber covered, twisted in pairs and soldered at the connections. It is especially recommended that the cable heads be mounted on a fireproof fixture and that the distributing board be made fireproof.

When arranged in this manner the circuits are available for testing purposes at the fusible arresters, where they may be tested out through the underground cables or in through the distributing and operating switchboards. When an office is so arranged it is of advantage, therefore, that the testing should be done in this terminal and distributing room, and that this room should be accessible without passing through the operating room. The terminal and testing room should be in charge of the chief inspector, by whom all circuits would be tested, and who would have charge of the general work of the exchange. There should be supplied for his use a telephone outfit, with connections to the office manager or chief operator ; circuits through the operating board ; a circuit to the generator and power tables, and also to plugs available at the cable heads, by means of which line or office tests may be made. He should have also a Morse outfit with relay and key, with a battery circuit included, and be supplied with a galvanometer outfit and a Wheatstone bridge.

While it is not recommended that at every exchange office there should be kept additional and more delicate instruments for making insulation resistance, or capacity tests, it is expected that in each company these appliances are available, and they may be connected for such tests through this chief inspector's apparatus.

In the operating room of the larger exchanges, we recommend that there be placed a multiple switchboard adapted for metallic circuits. This will extend, preferably, in one line at about 4 feet from the wall. The number of circuits terminating at each section of the board will largely depend upon the average daily use of the telephones in the exchange. Broadly, however, it may be stated that one operator wil handle 100 lines, if not burdened with the making of tickets or the handling of incoming local trunk wires. If branch offices exist in the exchange, the incoming trunk wires are preferably to be handled on the first one or two sections of the board, and the toll-line business preferably handled at the first section. At this section connections may be made requiring tickets or other records, such as checks on toll or long-distance business. If incoming trunks from a branch office are handled, they should be operated preferably by operators having, in connection with their telephones, a "talking circuit," its two branches extending "open" to the branch exchanges, so that calls received by these operators would be through his telephone. The trunk lines should be so arranged, however, that they may be operated by ringing calls in the usual manner if desired, without regard to the talking circuit.

At the subscribers' sections, three operators' outfits should be provided in the usual manner, excepting that double plugs, cords and ringing keys are used, and the talking circuit is bridged, not looped. The line circuits would extend through this board in the usual manner, the line and test wires being twisted together in pairs throughout the cables and operated as the two sides of the metallic circuits. After passing through the last multiple board, the circuits would extend through an intermediate distributing board, placed preferably immediately back of the multiple sections. At this board the circuits may be distributed to such answering jacks and drops as may be desired. These answering jacks and drops are arranged in front of each operator, the drop being of high resistance and retardation, preferably of what is now known as the tubular pattern, and bridged across the circuit which extends from it to the answering jack, where it is to open until a plug is inserted. By this arrangement the line drop itself is used for the disconnection signal. The advantages of having the line and clearing out drops identical have been appreciated within the last two or three years, especially in the use of single-cord boards, in which type of board the work of clearing out and watching connections is probably better done than in any other. In a board so arranged it will be seen that when two metallic circuits are connected together all the advantages of a metallic circuit are preserved. In all cases grounded circuits extended to the exchange through metallic circuit cables should be connected to ground at the outer end of the cable, the unused wire of the pair being grounded at that point. Therefore, when a grounded circuit is connected to a metallic circuit by means of this return wire, the advantages of the metallic circuit are extended to the outer or grounded end of the cable, from which points of course, the single wire will be subject to such interferences as its exposure may bring into play. The return wire is by no means thrown away, but is thus utilised throughout the cable. When two grounded wires are connected together they are practically preserved from interferences from adjacent wires throughout the cables and the operating apparatus by the shield of the twisted mate, which is grounded at its extreme ends. As all of these wires enter the office in pairs, it is essential that the use of each wire of a pair should be distinguished throughout its entire length, and it should be provided that in the cables, as well as throughout the switchboard, the white wire be used for the line and the coloured wire for the test.

With the extension of metallic circuits it is often asked how they may be utilised for the service of two or more subscribers on the same circuit. Probably the best results are accomplished by bridging the different instruments on to the two sides of the metallic circuit, using a ringer magnet at each instrument, of high resistance and retardation. By this arrangement the electrical balance is preserved, and no alteration in the ordinary form of operating apparatus is made necessary.

It has been the practice, heretofore, to loop intermediate sets of instruments into a circuit. At first this practice was persisted in when metallic circuits were introduced, additional instruments being looped into the side of the circuit. Such an arrangement, however, destroys the balance, and the instrument so connected will be subject to disturbances as loud as the line is capable of producing, and it will also be a source of disturbance to the other instruments in the circuits. By connecting all instruments, however, in multiple arc, *i.e.*, bridging across the circuit, nothing is lost in transmission, if the coils have sufficient retardation and the electrical balance necessary to the proper working of the metallic circuit is preserved. Systems have also been devised whereby a third ringing wire is legged on to the metallic circuit extending through the ringer magnets of all the instruments. This wire is open when the telephone is removed from the hook. It seems that at the time this latter plan was thought of the successful results of the bridging-in system had not been appreciated. In a number of instances attempts have been made to eliminate disturbances on grounded wires from electric railways and electric lights, by the use of a common return wire. While this has been of advantage in some cases in connection with single wires, the common return has no advantage as forming a part of a metallic circuit, and its use in direct connection with a metallic circuit is not to be thought of.

With circuits arranged as detailed above, the entire central office and cable plant is provided against inductive interferences originating within their limits, and the exchange is in condition to be easily changed to a complete metallic system.

Of course, it is recognised that very many of our large exchanges equipped with multiple boards, are now wired only for grounded circuits, and are, therefore, not to be operated on the plan indicated. There are, however, at these exchanges demands for metallic circuits and instruments to be used for local and long-distance work. By their use advantages are obtained in largely overcoming local inductive interferences. Such circuits may be arranged advantageously on the plan of what is known as a combination loop. This is a local metallic circuit so arranged as to extend as a metallic circuit through the long-distance or metallic circuit switchboard, where one branch is grounded, the other branch extending in the ordinary manner as a single wire through the local exchange. Locally, the wire is handled in the usual manner. At the combination board, however, the circuit extends to two jacks, and is handled by means of a twin plug. If in combination with a multiple board, the jacks are so arranged as to provide the usual "busy" tests when a plug is inserted. The circuit led by the twin plug and double cord at this combination should have all the advantages required for long-distance work. It is also found that in grounded circuit multiple boards very much of the induction which is occasioned by the old method of wiring may be overcome by using double plugs and cords, the outer shell of the plug being connected directly to the ground, by means of which the test ring is grounded independently of the line wire. During the transition period from grounded to metallic circuit apparatus, therefore, we would recommend the use of the combination board, and of the double plug and cord in connection with a multiple switchboard. It might appear at first that by using double plugs and cords on a multiple board wired on the old plan, the apparatus throughout could be operated for metallic circuits. This, however, is not the case, as owing to the fact that the wires are not twisted in pairs, there is actually more induction between wires in the board when operated as metallic circuits than on the plan indicated for operating grounded circuits.

At many of the Eastern cities through which the main lines of the Long-Distance Company pass, special metallic circuit switchboards have been placed for the purpose of handling these circuits and such local metallic circuits as were to be connected to them. In order to avoid all possible leakages or troubles in these boards, it has been thought advisable to connect each wire of the metallic circuit to a separate spring jack. These jacks are arranged in pairs and handled by means of a twin plug. This consists of two ordinary round plugs in one handle. Adjacent to this board is placed a testing board, through which the wires pass, and at which they may be handled for testing purposes in either direction. In connection with one or more of the local circuits on the board are placed repeating coils, which terminate in single lines in the local exchanges. The form of the repeating coils and the method of connection are now well known. In connection with these switchboards are the long distance metallic circuits.

In the building of these lines probably more attention has been paid to the requirements of a high-class service than in any other existing plant. Their record in maintenance and in service performed during the past three years is too well known to need comment. It is of interest, however, to state that on the oldest of these extensions, being the line of 25 wires between New York and Philadelphia, there are probably to-day fewer interruptions than at any previous time, the line having shown absolutely no deterioration.

On these long distance lines the problem of overcoming inductive interference from one circuit to another proved a very serious one. A system for so transposing the wires that no inductive interference exists between the pairs was, however, devised, and has been reduced to practice.

In ordinary pole lines, where the wires are placed on cross arms 12 inches apart, it is found that the inductive interference between adjacent metallic circuits experienced in an exposure of one mile is not serious, using the present long distance transmitter and hand telephone.

Adopting this as a basis, the systematic plan of transpositions provides that at distances of one mile the two branches of the metallic circuit on which the disturbing effect is experienced are so transposed that when the distant end of the line is reached each branch of the circuit has had a like amount of exposure to the adjacent wires. When metallic circuits are arranged in this manner inductive disturbances are entirely overcome. Where disturbances are caused by electric light or electric railway circuits of course transpositions must be made more frequently, as the amount of exposure which may be tolerated depends upon the intensity of the disturbing circuits. Transpositions have been best handled mechanically by the use of a special double transposition insulator recently devised for this purpose. This arrangement consists of two insulators, one being placed immediately above the other. The lower one has a hole through the top, and the pin extends up through it; the upper one is then threaded on to the top of the pin. In order that ordinary pins may be used a threading tool has been devised by means of which any pin may be turned down to the desired dimensions. During construction in transposing, the left-hand wire of a pair is brought around the upper insulator and then extended parallel with the cross arm, back of and around the upper right hand insulator. The right hand wire of the pair extends around the right hand lower insulator along the arm and back of and around the left hand lower insulator. The wires are tied at each insulator in the usual manner. Where existing circuits are to be transposed of course the wires in either direction must be "dead ended" at the respective insulators, and it is then usual to make the transposition by means of a short piece of insulated wire drawn tightly across the two wires. Where a large number of wires are to be transposed the plan of arranging them properly becomes more involved, and should be laid out by a competent telephone engineer.

If a metallic circuit for telephone purposes is constructed upon plans properly laid out every particle of outside disturbance may be overcome and the services may be made perfect. Any falling away from the high standard of these plans, however, at once detracts from the results, and should not be tolerated.

It must not be thought that what we have called "The New Era in Telephony," the various details of which we have attempted to describe, is something entirely new. This is not the case. To-day it is a commercial factor for which the public is making loud demands. Many of our largest exchanges have been reconstructed to meet the new requirements. New York, with a present office equipment for nearly 10,000 lines and nearly 50 miles of conference cable in circuit, is in the lead. In Buffalo and New Haven the entire exchange plants are being rearranged, while in Baltimore and in 11 New England cities, metallic circuit operating apparatus is shortly to be placed.

Although individual discoveries and inventions will undoubtedly lead to improvements in the detail of the appliances involved, yet we think that it will be by adhering to uniform practices, by a concerted action on the part of the companies taking up the new service, and a careful consideration of their experiences, that the greatest improvements may be looked for.

During the past very much has been lost by a lack of uniformity, and by the failure to find out and use what was really the best in appliances and general plans for the service. The methods of the East and the West have differed widely, and in some localities the business seems to have been run on the assumption that it was not there subject to the same electrical and natural laws as elsewhere. As a result there has been no fixed standard of telephone exchange service.

We have never heard of any exchange that its service was too good. This is, perhaps, owing to the nature of the business itself, and yet it is in spite of the very best efforts of telephone men and the liberal expenditure of money in providing what was thought to be best. There is probably no exchange to-day that does not

represent what was thought to be the very best engineering at the date of its construction. In the light of modern development, however, we see in these existing plants too many wires in single cables, too small wire, rusted out plants of iron or steel wire, deterioration of insulation in outside or inside wiring, twenty different styles of battery in service, as testimonials of the dearly-bought experiences of the past. We also see some exchanges overcrowded with operators, working as if the service was to be performed by the force of numbers. In some the benefits of modern appliances are lost because of the lack of proper utilisation. One exchange, for example, shows you 300 subscribers' lines terminating on one section of a multiple switchboard. In another you will find less than 100. It will not much overstate the case to say that in making plans for telephone exchanges, either the plans of similar establishments elsewhere have not been studied at all, or if they have been studied, the judgment of them has been so influenced by local conditions as to preclude their possible benefits. In this "new era," in which a perfected service is to be given, such engineering cannot possibly be successful. Our companies are now unanimous in telling us that nothing is too good for the service. Unfortunately, to those in direct charge of the service, this statement means very little. What is needed is some source of information from which we may learn just exactly what is good for the service. May not this association, whose membership comprises all well-known experts and telephone engineers, keep posted in telephone matters in various localities, and determine, for our mutual benefit, the best practical plans for telephone work? Thus there might be furnished to the companies included in this association detailed plans covering every branch of the telephone service, by means of which we may raise the standard of workmanship in our employés, remedy as far as possible the effects of the loose methods of past years, and properly provide for the requirements of the future.

The new era in our business has dawned brightly; our patrons see and appreciate it; skilful engineering will provide for its needs, and eternal vigilance will preserve it.

NEWS FROM AUSTRIA-HUNGARY.

[FROM A CORRESPONDENT.]

ON the Vienna-Prague telephone line, concerning the opening of which I reported to you, communication began on October 1st, of this year, and has now been extended to the subscribers of both telephonic nets, so that from this day both the subscribers of the Vienna Telegraph Company, as also to the town participants and the public speaking cells can correspond with the Prague subscribers of the telephone company of Austria. That this telephonic connection meets a want which has been very sensibly felt appears from the circumstance that on the first day of opening this connection was used—notwithstanding the relatively high prices (one florin for an ordinary conversation lasting three minutes, or three florins for an "urgent" conversation of the same length) by 250 subscribers.

The underground telephonic intercourse makes altogether, in Austra-Hungary, very satisfactory progress. The line Vienna-Buda-Pest is to be thrown open for intercourse on November 1st, and in the next year the three celebrated summer resorts in Salzburg territory —Gmunden, Ischl, and Aussee, will be connected with each other and with Vienna by means of the town telegraph.

In the works of the Buda-Pest electrical town railway (Siemens and Halske) there have occurred in the last week of September repeated interruptions. Indeed, the traffic had to be completely suspended for a short time. These irregularities—as it appears from a report made by the undertakers to the city—are due, not to the electric installation, but to the steam boilers which were imperfectly constructed. This statement is corroborated by a commission of investigation sent out by the Municipality. At present the line is again in action in all parts, since the traffic—until the final re-organisation of the steam boilers—is provisionally maintained by means of auxiliary locomotives.

At Temesvar, where, as it is well known, the Brush Company fitted up, last year, an installation of transformers, private lighting is now supplied from the central station, and makes satisfactory progress. Next the Synagogue there will be supplied with electric light, and this, to my knowledge, will be the first electrically lighted Synagogue in Austria-Hungary.

The electric lead of the Temesvar installation occasioned about two weeks ago a peculiar misfortune. A miller's apprentice, who lost his equilibrium in the second storey, had, to save himself from falling, laid hold of a primary wire running about a metre below the window. In falling he seems to have brought his left arm above the wrist in contact with the second primary wire, which—as the insulation of the leads had been totally soaked through by a fall of rain which had lasted for some days—occasioned his immediate death. The passers-by had their attention attracted by a peculiar crackling sound, and with much difficulty they succeeded in extricating the dead lad from the conductors.

One of the richest and most respected of the Hungarian magnates, Count Nicholas von Esterházy, has caused a very artistically designed and splendidly executed private theatre to be erected at his beautifully situate castle of Totis. It is illuminated in all parts with the electric light. The theatre forms an annexe to the buildings of the Winter Riding School. The entrance is from the great glass court leading to the vestibule, in which are the wardrobes for the public. From here we arrive by a broad marble staircase into the parquet, and to the right and the left there lead two broad stairs to the estrade of the cavalier seats. At both sides of the proscenium roomy boxes are arranged, and opposite to the stage there is a special box. Above this special box there is a spacious balcony for about 100 people; altogether the theatre holds about 300 persons.

As the theatre, like the castle Totis, altogether commands one of the loveliest views in a charming neighbourhood, the electric installation for supplying the light could not be erected near the castle, but it has been placed in a sawmill belonging to the estate, at a distance of 1,300 metres. Here there is a Zipernowski alternating current machine, of the model A, supplying 12 ampères and 1,000 volts, driven by a 15 horse-power turbine. The lighting, which is effected by means of transformers, comprises 160 glow lamps on the stage, 30 in the orchestra, 80 in the auditorium, and 80 in the adjoining rooms, circus, dining rooms and atelier.

This comparatively small theatre is fitted with all modern theatrical appliances, *e.g.*, for the production of colours, and for the regulation of the light.

The formal opening took place on the 4th of this month before a numerous and select audience, and in presence of the Archduke Otho and the Duke of Braganza, and numerous representatives of the highest Hungarian nobility.

CONTINENTAL NOTES.

[FROM A CORRESPONDENT.]

The *Annales de l'Electricité* states that M. Kotovich has undertaken at the Moscow Physiological Laboratory a series of experiments as to the comparative sensibility of the telephone and the frog under the influence of the effects of induction which manifest themselves in electro-physiological experiments. M. Kotovich used a Siemens telephone, which, according to him, was much more sensitive than those of Golubitsky and Bell, and he found that, when continuous currents were employed, the distance between the bobbins at which contractions could be made to appear varied from 45 to 58 centimetres, and that at which the sound of the

telephone was heard most feebly varies from 135 to 164 centimetres, he deduces from this that the telephone is much more sensitive than the frog. In another series of experiments M. Kotovich made use of alternating currents, and in this case his conclusions were contrary to the preceding; and he concluded that the relative sensibility of the telephone and the frog depends largely on the nature of the currents employed.

An interesting discussion took place at the Railway Congress in Paris on means of traction, which subject, by the bye, figured on the programme of the Milan Congress of 1887, but which was then adjourned. M. Michelet, manager of the General Belgian Company of Secondary Railways, who had been appointed reporter for the session just ended, successively studied in his work electric traction by accumulators or by conductors, compressed air motors, hot water motors, soda motors, gas motors, automobile carriages, the Fell central rail system, toothed rack traction, funicular traction by alternating movement, and, lastly, funicular traction by continuous movement. The numerous figures given by the author were discussed by MM. Beguami, Decauville, Meyer, Ellisen, and others, and the section finally adopted the following resolutions:—1. Electrical accumulators may be employed more especially on lines with low gradients served by automotor carriages.

They will not be sufficient in cases where an effort of heavy traction is required. 2. Electrical traction by conductors may be employed to all workings where other means of traction present serious inconveniences. 3. Hot water and compressed air motors are substituted for locomotives under the same conditions as electrical traction by conductors, when the length of the journey and the intensity of the efforts do not form an obstacle. 4. The automotor carriages, Rowan type, find their application in the working of branch lines of light traffic; the length of these lines presents no obstacle to the employment of this system. 5. As to the means of working lines with steep gradients, the toothed rack appears master of the position, both as regards the expenses of the first establishment, and also as regards working expenses. 6. Lastly, the funicular system by alternating movements is only applicable to straight lines of limited length, and appears specially to be recommended when the motive power can be furnished by a natural force.

The electric lighting of the towns of Albaute and Ternal, in Spain, has been entrusted to Planas, Flaquer et Cie.

According to statistics recently published, the number of people killed by lightning in France from 1852 to 1882 was 653, of whom 487 were men, and 166 women, most of those killed being struck in the open.

We learn from Paris that the Administration of Posts and Telegraphs has directed an interesting enquiry on the subject of communes not provided with telegraph offices. The installation and working of a telephonic communication costing much less than those of a telegraphic service, an examination is to be made whether a telephone line cannot be given to the communes which wish to be joined to a head quarters, in default of a telegraph line.

An amusing scene was witnessed last week in Paris. In the evening the horses which passed along the boulevard at the top of the Rue Louis le Grand seemed seized with vertigo, jumping about like sheep. The disorder among the traffic soon became so great, that the police officials had to stop the traffic. The cause of the trouble was soon discovered. One of the electric cables placed under the thoroughfare, and leading to a lampstand placed on a refuge, had become disarranged, and, coming in contact with the damp wooden pavement, the horses, in passing over it, received a shock. Some of the company's workmen were soon on the spot, and restored things to their normal condition. The next morning, however, some slight shocks, it is stated, were experienced at the same place.

Among the new companies lately formed in Paris is that of Perreur-Lloyd, which was registered on August 9th, the founders being MM. Perreur *père* and Perreur *fils*. The objects of this company are as follows:—1. Lighting in France and all its colonies by electricity. 2. The creation, provision of money for, and the working of stations. 3. The sale of all products and subproducts. 4. The obtainment, purchase, and working of all patents relating thereto. 5. And all financial and industrial objects generally. The capital has been fixed at 500,000 francs, divided into 1,000 shares of 500 francs each; out of these 1,000 shares 600 have been given to the founders, half each, in satisfaction of their claims. There have also been created 1,000 founders' shares, entitled to 40 per cent. of the profits. The duration of the company is to be 99 years. The founders have been appointed directors for 10 years.

Under the heading of "Dedicated to Mr. Preece," the *Independence Belge* says:—M. Eugène Person, aged 21, was employed in the electric lighting at the Eden Theatre, Paris. Last night, while at work, he slipped and mechanically endeavoured to save himself by clutching the conductor wires which were near him. The young man, who was not wearing India-rubber insulating gloves, fell backwards. He was picked up insensible, and taken to the Beaujon Hospital, where for more than an hour efforts were made to resuscitate him by the methods generally employed in cases of asphyxiation, but they were useless—he was dead.

According to a measure just submitted to the Italian Chambers, the establishment and working of the telephone for public use can only be carried out by virtue of a Government concession. The concessionaires and the Government, when it undertakes itself the establishment and working of the telephone, will have the right to pass the wires either over private properties, or underground through these properties; in the last case, however, an eventual indemnity is to be given, to be determined, in case of dispute, by the Prefect, those interested having their remedy before the judicial authorities. The maximum rate of charge in the interior of a commune or group of communes will be 200 francs per year within a radius of 3 kilometres from the central office. The maximum charge for inter-communal communications will be 1·50 franc for 5 minutes' conversation, for distances which do not exceed 100 kilometres, and two francs for greater distances.

By a warrant, dated Paris, September 19th, the bronze medal of Posts and Telegraphs has been conferred upon MM. Barbagelata and Porret, two of the crew of the *Anadyr*, whose courage was most conspicuously displayed in saving despatches at the wreck of that vessel at Aden on July 11th, 1889.

ELECTRIC LIGHTING IN THE CITY.

REPORTS OF THE STREETS COMMITTEE, COL. HAYWOOD AND MR. PREECE.

A SPECIAL meeting of the Commissioners of Sewers has been convened by Mr. G. Manners (the chairman), to be held on Monday, to consider the report of the Streets Committee, the abstract of tenders, together with reports of the engineer and Mr. Preece, and the modifications proposed by the Metropolitan Electric Supply Company and the London Electric Supply Corporation. The Streets Committee are Messrs. F. F. Day, G. Manners, G. N. Johnson, H. H. Bridgman, A. Pickering, Richard Stapley, G. Taylor, J. L. Sayer, and H. W. Greenwood, and their report, which was sent out to the members of the Commission last Monday, is as follows:—

"We whose names are hereunto subscribed of your Streets Committee, to whom on the 26th day of February last it was referred to advertise for tenders for electric lighting based upon the conditions then approved, do certify that in the first place we instructed the engineer and solicitor, with Mr. Preece, the electrician, to prepare the necessary form of tender and specification.

"This having been done and advertisements issued,

tenders were received on the 10th of May last from the undermentioned companies, viz. :—

"The Anglo-American Brush Electric Light Corporation, for the west and central districts.

"The House-to-House Electric Supply Company, for the eastern district.

"The Metropolitan Electric Supply Company, for the western district.

"The Laing, Wharton and Down Construction Syndicate, east district.

"The London Electric Supply Corporation, all three districts.

"These were referred to the engineer and solicitor for consideration, with power to consult Mr. Preece thereupon, and the engineer, in conjunction with Mr. Preece, prepared an abstract of the said tenders.

"In the meantime we received a copy of Major Marindin's report to the Board of Trade on the various applications for provisional orders and licenses under the Electric Lighting Acts, in which he says, in regard to the City, 'The Commissioners of Sewers, acting for the Corporation, are endeavouring to obtain tenders for the lighting of the City, but I see no reason why the principle that all such lighting should be done under statutory powers and obligations should be departed from in their case;' and the Commissioners have since received notices from the Anglo-American Brush Electric Light Corporation, Metropolitan Electric Supply Company, London Electric Supply Corporation, and the Laing, Wharton and Down Construction Syndicate, that they will in the next Session apply for provisional orders to supply electricity within the City of London.

"We have also had before us a model form of provisional order prepared under authority of the Board of Trade.

"On carefully considering the tenders sent in, together with the suggestions of the companies, in regard to conditions, it was found that the tender of the Anglo-American Brush Corporation was the only one practically in accordance with the specification, and, under the advice of Mr. Preece, we instructed the officers to negotiate further with the Metropolitan Electric Supply Company and the London Electric Supply Corporation with a view to arrange similar terms with them.

"This has since been done, with the result that they have severally modified the terms of their tenders, so as to bring them into uniformity with that of the Anglo-American Brush Corporation, and, broadly, all these three companies now agree to accept the terms of the provisional orders now sanctioned by the House of Commons.

"The prices per annum per arc lamp are as follow :—

	£	s.	d.
"London Electric Supply Corporation	24	3	10
"Metropolitan Electric Supply Company	26	0	0
"Anglo-American Brush Corporation	26	0	0

"But the London Electric Supply Corporation propose to extinguish half the lamps at midnight.

"After full consideration we beg to recommend that the tenders of the said three companies be provisionally accepted, subject to their agreeing to enter into a contract for 21 years, determinable by either party at the end of 7 or 14 years, and the London Electric Supply Corporation waiving the condition as to extinguishing half the lamps at midnight.

"That the three districts into which the City is divided for this purpose be allotted as follows, viz. :—

"No. 1, west, to the Metropolitan Electric Supply Company.

"No. 2, central, to the Anglo-American Brush Corporation.

"No. 3, east, to the London Electric Supply Corporation.

"To light the main thoroughfares by means of 395 arc lamps will cost £10,024, in place of 1,730 gas lamps, now costing £5,530 per annum; but whilst the price will not be double, the amount of light will be many times greater."

In notes appended to this report it is stated that the London Electric Supply Corporation having agreed to waive the condition as to extinguishing half the lamps at midnight, say the price is to be £26 per lamp; and that all the companies agree to make the contract for public lighting determinable at the end of 7, 14, or 21 years.

Colonel Haywood (the engineer) reports that he has, in conjunction with Mr. Preece, prepared an abstract of the various tenders sent in.

Mr. Preece, after quoting from the Board of Trade report, says:—"I beg to point out that it appears to me that Major Marindin has not taken sufficiently into his consideration the commercial element that enters so strongly into one side of the question.

"He regards the City merely as a local vestry, with some ancient rights and privileges that have to be respected; but he forgets to note that the amount of lighting, and the capital necessary to be expended in the City, far exceeds that for any other portion of the metropolis. He seems to regard the City as a convenient route or way to enable an electric lighting company to carry their mains from the other side of the Thames to Clerkenwell, forgetting that there is a railway connecting the two places that offers a very convenient route for mains. But the chief point that he has neglected is the £ s. d. point that the guardians of the public interest have to consider so carefully, viz., that the streets may be illuminated with the best artificial light, obtained at the cheapest possible rate. The Commissioners of Sewers have not only to look after the effective lighting of the streets, but they also have to regard themselves as the custodians of the public purse. From this point of view they have to select not only the best and cheapest lamp, but they have to select as contractors to conduct the service, those whose financial position and standing in the City is above reproach. Major Marindin offers very powerful evidence in favour of the lighting of the Metropolis being done rather by rich and large companies than by small and speculative concerns."

The report of Mr. Preece thus concludes :—

"The prices that it is proposed to charge for an ordinary arc lamp vary between the limits of £26 and £45 per annum. The proposed distribution of light varies between the ratios of one arc lamp to three gas lamps, and one arc lamp to five gas lamps. In some cases it is quite clear that the desire has been to illuminate the City more brilliantly than any other city in the world, and I think in some cases this has been done to excess. My own view is, that one arc lamp should, on the average, replace four gas lamps, and that the normal arc lamp should not cost the City more than £26 per annum. If this were the case, then the Commissioners would not be called upon to pay much more for electric lighting than they pay now for gas. I think all these points that I have enumerated require further consideration, and I do not feel myself in the position at the present moment to make any definite report to the committee as to the course which it is advisable for them to pursue."

This is followed by the undermentioned joint report of Col. Haywood and Mr. Preece :—

"In accordance with the resolution arrived at at the last meeting of the Streets Committee, we have had several interviews with the representatives of the London Electric Supply Corporation and the Metropolitan Electric Supply Company. The result is that they have each considerably modified the terms of their tenders, so as to bring them to a form uniform with that of the Anglo-American Brush Corporation. Broadly they all agree to accept the terms of the original specification, modified only in terms of the provisional orders now sanctioned by the House of Commons, but not yet passed through the House of Lords.

"The price proposed per annum per arc lamp is as follows :—

	Original. £	s.	d.		As modified. £	s.	d.
London Electric Supply Corporation	31	15	0	...	24	3	10
Metropolitan Electric Supply Co. ...	30	0	0	...	26	0	0
Anglo-American Brush Corporation	30	0	0	...	26	0	0

"The principal modification proposed by the London Electric Supply Corporation is that half the lamps shall be extinguished at midnight. The other modifications are principally legal, and will be examined and reported upon by the solicitor.

"We think that the Streets Committee can now safely recommend the Commissioners of Sewers to accept provisionally the tenders of these companies and to allocate the districts as follows :—

"No. 1, West.—The Metropolitan Electric Supply Company.

"No. 2, Central.—Anglo-American Brush, &c., Corporation.

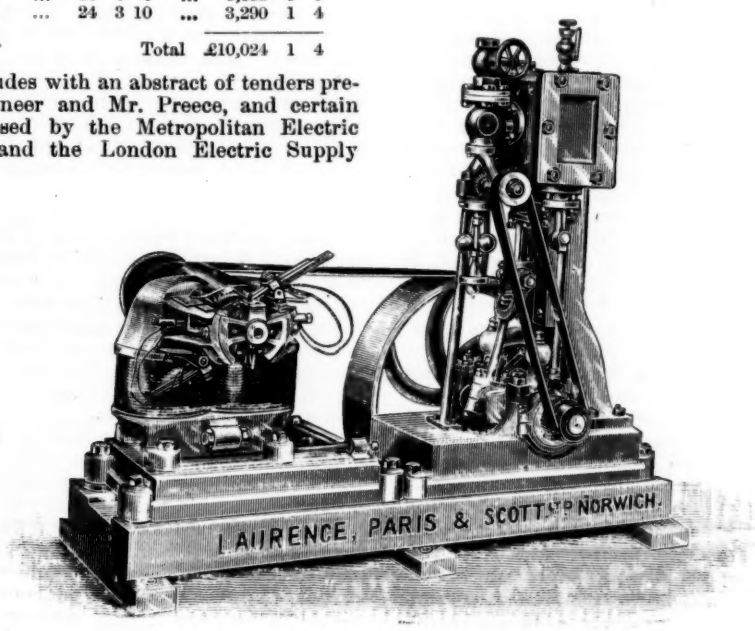
"No. 3, East.—London Electric Supply Corporation.

"If this is approved and confirmed by the Commission, a complete contract will have to be drafted by the solicitor, and many details and arrangements completed with those who have tendered ; and this will have again to be sanctioned by the Commission.

"The final cost will be :—

District.	No. of arc lamps.	Price per lamp. £ s. d.	Total £ s. d
No. 1. ...	121 ...	26 0 0 ...	3,146 0 0
No. 2. ...	138 ...	26 0 0 ...	3,588 0 0
No. 3. ...	136 ...	24 3 10 ...	3,290 1 4
		Total	£10,024 1 4

The report concludes with an abstract of tenders prepared by the engineer and Mr. Preece, and certain amendments proposed by the Metropolitan Electric Supply Company and the London Electric Supply Corporation.



BIRMINGHAM EXHIBITION.

WE illustrate herewith a small combined plant of engine and dynamo exhibited by Messrs. Laurence, Paris and Scott, Limited, of Norwich.

The engine has a 4½-inch cylinder with 4½-inch stroke, and runs at about 400 revolutions per minute. It has a steel crank shaft with balanced crank, the bearing surfaces are made very large, and the lubricating arrangements are suitable for continuous running.

The dynamo is one of this firm's D type machines compound wound running at 1,400 revolutions per minute, and it has an output of 1¼ kilowatts. It is driven by a 4½-inch belt, made of thin flexible leather. Owing to the abnormal width of the belt no difficulty is experienced in transmitting the necessary power from the engine to the dynamo although the drive is so very short. The dynamo is provided with sliding rails, so that the belt may be tightened whilst running.

Altogether this appears to be a very compact and efficient 20-light plant and runs very smoothly. Steam not being available the plant is shown running at full speed by means of current supplied to the dynamo, which thus works the engine and at the same time puzzles the visitors.

Several motors of the same pattern as this little dynamo are utilised in various parts of the exhibition to drive machinery in motion. They are all fitted with a special starting switch mounted on the pole pieces. This consists of a small pivoted lever drawn upwards by a light helical spring, and in work pulled downwards by the pole pieces. The object of this lever is to short-circuit the special series winding on the field magnets. This series winding consists of about 500 turns of comparatively thin wire, and serves the purpose of a temporary resistance in the armature circuit in starting the motor, at the same time strengthening the magnetic field. As soon as the magnets are excited the pivoted lever is attracted on to a small detent which is removed as soon as the armature has attained a speed approaching its full speed. The pivoted lever thus falls to its lowest position, short-circuiting the series winding by means of a mercury cup. When the motor is stopped the series winding is again automatically introduced into the armature circuit by the rising of the pivoted lever, so that there is no risk of starting the motor without the extra resistance in the armature circuit.

One of these motors is shown attached to an ordinary saw-bench, forming a portable saw. Another drives a large Blackman air propeller in the machinery hall where two of this firm's dynamos are at work; one driven by Messrs. Crossley's 9 H.P. gas engine has a normal output of 90 ampères at 100 volts, and the other, driven by Messrs. Robey's new high-speed compound engine, has a normal output of 120 ampères at 100 volts. This machine has, however, on one or two occasions been run at considerably over its normal output. All these machines have deep and narrow slots cut in the drum armatures to receive the winding, which is thus securely embedded within the body of the laminated iron drum. The field magnets are made of a special cast iron, and this, together with the peculiar construction of the armature, makes the size of these machines seem small for their output and speed. The speed of the 120-ampère machine, when giving 100 volts, is 725 revolutions per minute at full load and 760 revolutions per minute with no load, so that it is "over-compounded" about 5 per cent.

We understand that Messrs. Laurence, Paris & Scott, are busy with several important improvements, notably a new meter for the use of electric supply companies, which is expected to take a very high position amongst its competitors.

INDUCTION AND OTHER THINGS.

(*Continued from page* 412.)

LAST week, when discussing the practical unit of self-induction, we hinted that coefficient of self-induction was not length. Some writers make out that coefficient of self-induction is length; others say it is of the nature of length, which seems to be merely a round-about way of saying it is length; others write of a coefficient of self-induction of so many centimetres; and more say that the coefficient of self-induction is measured by a length. This is a vague sort of statement, but seems to be a guarded way of saying that it is length. Many writers bring forward an example or two to show that what they say has a physical meaning. Thus Dr. Fleming, wishing to show that current is the square root of force, whatever kind of entity that may be, instances somewhere in his book the case of a dynamometer, where the force varies as the square of the current. We see no logical connection between the nature of electric current and the force on dynamometer coils. The example might be used equally well to show that as the force varies as the turns of copper wire in one of the coils current is the same as turns of copper wire, that is to say, it is elongated copper wrapped with silk. This is nonsense, due to the omission of "number of" before "turns of copper wire."

Similarly, the usual example of the physical meaning of resistance as velocity can be used to show that electromotive force or current or anything else is velocity.

If the fact that the number representing the speed of a bar of unit length running along a slide across unit field developing unit current in the circuit is equal to the number representing the resistance of the circuit, it shows that resistance is of the nature of velocity; the fact that the number representing the electromotive force is also equal to the number representing the speed goes to show that electromotive force is also speed.

When the youthful mathematician multiplies apples by pennies he is jumped upon; but if his teachers do the same thing there is supposed to be some deep and hidden meaning in their practice. We approach this mysterious subject with trepidation, for, as a glance at the 14th Report of the Association for the Improvement of Geometrical Teaching, of all books in the world, will show, some people think apples may be multiplied by pennies with perfect rectitude. We prefer, however, to adhere to the traditions of our youth. When we wish to know the price of a dozen apples at two pence each we do not operate upon the apples or the coins themselves; we take the number of apples and multiply it by the number of pence each costs, and divide the number obtained by the number of pence in a shilling. We even go so far as to say length squared is not area, and that all mathematical operations are performed on abstract numbers only. We depart from one tradition of our youth, however, and hold that it is incorrect to say, "Twice two are four." Two is (not are) the name of an abstract number, and is therefore singular in number. Twice is a numeral adjective, and does not alter the number of the qualified noun. We therefore say, "Twice two is four."

In many text-books in which the "Dimensions of Units" are discussed, it is stated at the beginning that, for instance, [L] is the concrete unit of length; after a little it is found that [L] is really what Prof. James Thomson called the *change ratio* of the unit of length; that is, it is simply a ratio of the new unit to the old, the number of times one will go into the other. Sometimes it appears to come on the scene as the ratio of the new unit to the old one, and later on it becomes length itself; in fact, a fallacy is apt to creep in. Even if we were to assume that a symbol could represent a concrete unit, we must suppose that when one concrete unit is divided by another concrete unit with a different numeric, the concreteness cancels out, and leaves simply an abstract number. If M, L, and T are numbers, or change ratios, of course such ideas as resistance being velocity at once becomes nonsense. Writers also often use suche xpressions as $C = \frac{E}{R}$. In the first place, all that can be said is that the number represented by C is equal to the number represented by E, divided by the number represented by R; and this is only true in a consistent system. Generally speaking, the sign = should be replaced by the sign of variation, $\propto$. Dr. Fleming, in one place, says that in a particular equation = means "is measured by," = can mean nothing but "is equal to." $2 \times 2 = 4$ means that two multiplied by two is four; not that it is measured by four. At other times Dr. Fleming uses the expression "is numerically equal to," whereas no other sort of equality exists in mathematics.

It is a curious fact that a slip is made in Maxwell's dimension table where the "dimensions" of K in the electrostatic system and μ in the electro-magnetic are given as zero. Of course they should have been either 1, or $[M^0 L^0 T^0]$. It is still more curious that this slip is copied into every, or almost every English text-book. It is corrected in Joubert and Mascart's treatise. Similarly, to be perfectly consistent, such dimensions as, say, of capacity in electrostatic measure should not be given as [L], but as $[L^1 M^0 T^0]$; M and T need not be suppressed for the moment. It is strange that a writer who would talk of a coefficient of self-induction of a kilometre would never talk of the cosine of the magnetic inductive capacity of π; he would feel that there was some suspicion of nonsense there, though the dimensions are all right. Magnetic inductive capacity must be of the nature of an angle, or must be an angle, or must be measured by an angle, we do not care which.

So many great men multiply apples by pennies, that we must modestly remind readers that, as an eminent judge said, it is unnecessary to insert here and there "in my humble opinion," or "I think," as nobody writes anything more than his mere opinion.

Let us take it, however, that concrete numbers can be multiplied together, or that pairs of a concrete and an abstract number can be multiplied to give a concrete result, and see where we get to.

We are now so accustomed to the use of dimensions that it is quite natural to talk of the Scotch express going at so many microhms, or of the South Eastern trains as travelling at so many megamhos; so it would be difficult to get people to see the least absurdity in such expressions. Let us therefore go to some other branch of science.

Jevons, in his "Theory of Political Economy," uses dimensional formulæ. His concrete units are [M], [T] and [U]. [M] and [T] are mass and time, but [U] is the concrete unit of utility, a quantity which has, we fear, little to do with the subject under discussion. Without going into economic questions we may call [U] the concrete unit of exchange value, and we may define it in terms of [L] so as to get a correspondence between physical and economical systems. A C.G.S. unit of exchange value should, of course, be ridiculously small or outrageously large. As the concrete unit of mass is a cubic centimetre of water we will take as the C.G.S. [U], the value of a cubic centimetre of cold water. Economists point out that water has no value till labour has been spent on it, or unless it is scarce; our unit will therefore be a cubic centimetre of water delivered on the premises. This may be called the "stiver." The term may be spelled backwards to give the absolute unit of poverty. We have interviewed the water companies, and find the stiveroon is somewhere about threepence. The dimensions of income are thus $[L^3 T^{-1}]$, while the dimensions of area are, of course, $[L^2]$; it is therefore perfectly correct to talk of a resistance of a hundred pounds a year per acre. We sometimes wonder what posterity will think of us. If the New Zealander of Macaulay, or our prototype, or of whoever invented him, sitting on the ruins of St. Paul's, picks up a thing like a milestone labelled on one side "To Hanwell, one thousand pogglets," and on the other "From Colney Hatch twenty-five guinea megfarads per microhm per cubic second," what will he think of the common sense of the Nineteenth Century?

When we urged that only abstract numbers could be multiplied together or divided one by another, it was not forgotten that people might say that that is not the case, because vectors can be multiplied, and they are not mere numbers, but represent both length and direction. A vector does not represent direction, but relation of one direction to some other, or standard direction. This ratio of directions is purely a convention, and is represented by an abstract number. Similarly, the product of two vectors is the number of times a unit area will go into a conventionally produced area, and to give this a new direction another abstract number has to be taken into account. The other part of the product is the number of times a unit volume will go into an imaginary volume conventionally produced.

The application of vector methods to a subject like electricity where, for instance, motion, induction, and electromotive force act at right angles to one another seems almost to give the methods a physical meaning. It also seems to render the treatment of such subjects very much simpler. Such an expression as

$$\frac{d\,\text{R}}{d\,s} = c\,\frac{dy}{dt}\frac{dx}{ds} - b\,\frac{dz}{dt}\frac{dx}{ds} - \frac{d\,\text{P}}{dt}\frac{dx}{ds} + a\,\frac{dz}{dt}\frac{dy}{ds} - c\,\frac{dx}{dt}\frac{dy}{ds} - \frac{d\,\alpha}{dt}\frac{dy}{ds}$$

$$- \frac{d\,\Psi}{dt}\frac{dy}{ds} - \frac{d\,\Psi}{ay}\frac{dy}{ds} + b\,\frac{dx}{dt}\frac{dz}{ds} - a\,\frac{dy}{dt}\frac{dz}{ds} - \frac{d\,\text{H}}{dt}\frac{dz}{ds} - \frac{d\,\Psi}{dx}\frac{dz}{ds}$$

is, to say the least, somewhat tedious reading. Mark Twain would say it had a perspective. It was somewhat foreshortened in the original by the use of brackets. It can also be written out more fully, so as to appear even more impressive.

It is exceedingly difficult to follow the meaning of such expressions as this, especially if one is reading, say, on the top of an omnibus. Even if one can draw, a representation of all this on a plane in Chinese perspective is confusing. To imagine such expressions is akin to playing chess blindfold. How much simpler this is when put into the form,

$$\text{E} = \nabla\,\text{G}\,\text{B} - \dot{\text{A}} - \nabla\,\psi,$$

which means it all. Whichever method is best alone, we think students with limited time have reason to complain when both are used and mixed up together. Dr. Fleming deserves the thanks of the community for using block letters instead of German capitals. It is very annoying in one's reading to come across a thing like a tangle of snakes, and either have to wait till a German dictionary is accessible or guess at what is supposed to be represented.

While on this subject it may be mentioned that Dr. Fleming seems to have made a slip in his definition of Maxwell's "curl," and to have confused it with the line integral of the component of a vector round a finite closed curve. Thus, to find the curl of the magnetic force at a point, an element of area is described there and turned so that the line integral of the magnetic force round it is a maximum. This line integral is the curl of the magnetic force, and is taken as a vector normal to the little area. The curl of the magnetic force at a point is thus four π times the current density.

(*To be concluded.*)

Electric Lighting at Portsmouth.—The publication of the prospectus of the Portsmouth and South Hants Electric Supply Company, Limited, has occasioned quite a sensation, the list of directors and founders showing that the new undertaking is being backed up by many of the leading men in the town. The Commander-in-Chief, Admiral Sir Edmund Commerell, V.C., G.C.B., and several of the principal physicians at Southsea are among those who have a substantial stake in the company, which has decided to lose no time in obtaining the necessary Parliamentary powers. The Laing, Wharton and Down Construction Syndicate have also lodged an application with the Board of Trade for a provisional order enabling them to instal the electric light in Portsmouth.

LIGHTNING CONDUCTORS.

By S. ALFRED VARLEY.

(*Continued from page* 380.)

ENERGY.

WHAT energy is, and how it becomes associated with, and is stored up in matter, is involved in the deepest of mystery. We see it unlocked in the fire grate in the shape of heat and conveyed to the cylinders of the steam engine, where it diappears, and mechanical force takes its place. A little further on, the mechanical force produced in turn disappears, and the energy in some mysterious manner becomes transferred to the electricity of the dynamo system. The insulated wire of the dynamo circuit and the magnetic field in which the armature revolves form parts of a complete system, and to any spot within the limits of this system, the energy, now it is associated with electricity, can be silently conveyed to produce light, heat, mechanical force or chemical action.

Although we know nothing in respect to the nature of energy itself, we know it to be indestructible, and that, unlike electricity, which cannot be added to, or taken from matter, energy is capable of being added to and taken from it; the quantity of energy which can be imparted to matter or associated with the electricity of matter, seems also to be unlimited. The movement of matter in the performance of work, or the movement of electricity in matter, involves the overcoming of resistance.

Energy itself is indestructible, and the only thing that can happen to it is, that it may become changed into a shape useless to ourselves, and whenever it is associated either with matter, or with electricity, a certain percentage of it does become changed and is so lost. Now, for energy to be available for useful purposes, it must be associated either with matter, or electricity, but the greater the quantity of matter, or of electricity, a given amount of energy is associated with, the greater the percentage of energy which becomes lost from its being changed into a useless form, and therefore the transmission of energy through the medium of electricity will be found to follow what the writer in an earlier part of this article ventured to suggest as a general law governing the transmission of energy, viz., that the greater the amount of energy relatively to the vehicle of its transmission, the more perfect and complete will be the transmission.

In the examples previously given it was assumed that the resistance encountered in the electric circuit was that opposed by the metallic conductor, and that the internal resistance of the voltaic couples which set up the electrical motion was small enough to be a negligible quantity. Let a case be considered where opposite conditions prevail, and where the resistance of the metallic conductor is so small as to be practically inappreciable, the quantity of electricity set moving under such conditions will be determined by the internal resistance of the voltaic couples, and adding to their number will not appreciably increase the quantity of electricity, as each additional couple brings with it its own internal resistance, and consequently the resistance and the electromotive force become increased in the same ratio. The energy will, however, be increased in the same degree as the electromotive force becomes augmented, and there is theoretically no limit to the amount of energy which in this way may be associated with electricity, any more than there is theoretically a limit to the velocity, and, consequently, to the energy which can be imparted to matter.

The form which energy takes when combined with electricity, by adding to the number of voltaic couples, is that of potential or pressure, and its relationship to the electricity it becomes associated with, is very analogous to that of energy combined with matter in the form of high-pressure steam, water in a high-pressure hydraulic system, or a rifle bullet to which a high rate of velocity has been imparted.

We see, therefore, how perfectly matter and electricity in motion harmonise with one another, *at least* so far as the transmission of energy is concerned; there is, however, a difference between electrical motion and matter in motion which should not be overlooked; this difference arises out of the fact that when electrical motion is occurring the electricity set in motion is part of the conductor itself, and nothing is added to, or taken from the electrical system, whereas when energy is being transmitted through the medium of, say, a steam engine, or a hydraulic system, matter associated with energy enters the cylinders and pipes at one end and passes out of them, after parting with energy. Let us briefly consider what occurs in a hydraulic system through which water under pressure is being forced, and which is performing work, and let it be assumed a portion of the system is composed of pipes whose diameter is larger than that of the other parts, the pipes throughout their entire length will be subjected to an internal pressure tending to burst them, and the stress to which the system becomes subjected, will be greater where the pipes are larger, directly, as the internal diameter of this portion of the system is greater than that of the other parts. Now, in an electrical system, a portion of which is formed of a conductor whose section is larger than that of the other parts, the very reverse of what has been just described occurs, the electrical pressure tending to burst up the conductor is less where the conductor is larger, inversely as the sectional area of it is greater.

I proceed to analyse very briefly the action that takes place when matter is broken down and built up in a decomposition cell or plating bath.

Fig. 8 represents a voltaic couple, whose circuit is completed through two copper plates immersed in a solution of sulphate of copper.

When the circuit is completed, a current passes from the + pole of the voltaic couple to the left hand copper plate, through the sulphate of copper solution to the right hand plate, and back through the conductor to the − pole.

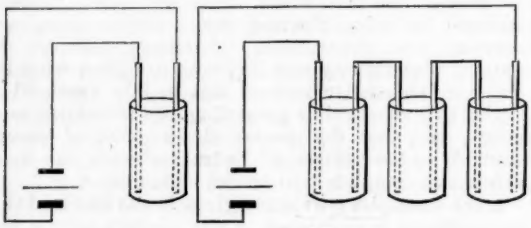


FIG. 8.

FIG. 9.

The electric current set up by the breaking down of the zinc and water molecules in the voltaic cell develops a corresponding action in the plating bath, the left hand copper plate becomes broken down, molecule by molecule, and new molecules of metallic copper are built up on the right hand plate. The rate at which the breaking down and building up of metallic copper occurs has reference to the rate at which the zinc in the voltaic cell is oxidised, and this rate is determined by the total resistance of the circuit. The actual weight of copper broken down and built up in the plating bath, compared with the weight of zinc oxidised in voltaic cell, is relative to the difference of their respective atomic weights. The atomic weight of zinc = 32·52, and that of copper 31·66, and therefore 31·66 parts of copper will be broken down and built up in the plating bath for every 32·52 parts of zinc broken down in the voltaic cell.

To avoid complexity let the internal resistance of the voltaic cell be disregarded, and let that opposed by the plating bath be taken into consideration only and assume this resistance to = 1; further, let it be also assumed that the zinc and copper have the same atomic weights, and that the zinc becomes oxidised in the voltaic cell at the rate of one ounce per hour, copper being broken down and built up in the plating bath also at a similar rate.

Energy is concerned in the building of atoms into molecules, much in the same way as it is concerned in the structure of buildings where bricks and stonework have to be raised and fitted into their respective places, and when molecules are resolved again into atoms, energy equivalent to that originally concerned in building them into molecules becomes unlocked and set free. Now, in the plating bath the energy unlocked by the act of breaking down the molecular structure of the left hand positively charged plate becomes transferred to the right hand negatively charged copper plate, and becomes there locked up in the new molecular structure created, the only work performed being overcoming the resistance which all circuits in a greater or less degree oppose to electric motion.

Fig. 9 represents a voltaic couple connected through three plating baths opposing three times the resistance of the single bath, the rate at which zinc will be broken down in the voltaic couple will be decreased to $\frac{1}{3}$rd of an ounce per hour, and copper will be broken down and built up in *each* cell at the rate of $\frac{1}{3}$rd of an ounce per hour; but as there are three baths, an ounce of copper per hour will be deposited at one-third of the cost for zinc.

The question may be fairly asked if the economy with which plating operations can be effected becomes greater when more than one bath is employed, why not increase their number indefinitely. The answer is to be obtained by sitting at the feet of Nature. If we only do this we can hardly fail to observe Nature does not love extremes; her laws, it is true, are absolute, and never vary; she governs, however, not by one but by many laws, and the phenomena presented to our gaze are due, not to a single force of law, but to a composition of laws or forces. The practical impossibility of obtaining a really perfect vacuum is a case in point; the compression of gases is another example. Gases resist compression within certain defined limits, when another law asserts itself, which causes the molecules to come closer together, then mere compression is capable of effecting, and converts the gaseous molecules into an incompressible liquid; other illustrations could also be given from mechanical science.

In an earlier portion of this article it was pointed out that a statical charge was a storage of energy. In connection with the so-called "impulsive rush experiment," the well-known fact was incidentally referred to, that when a Leyden jar or a charged cloud discharges into a condenser, the potential of the electricity becomes reduced directly as the capacity of the condenser into which the discharge passes. It was further pointed out that two platina plates immersed in water or acid and water, formed a Leyden arrangement of low resistance and large capacity *relatively* to ordinary glass Leyden jars, and that a Leyden arrangement so constructed might be regarded as a connecting link between the storage battery and an ordinary Leyden arrangement. The writer now hopes to be able to demonstrate there is no hard and fast line which separates a Leyden jar from the most perfect conductor conceivable; that, in fact, paradoxical as it may appear, a perfect conductor becomes an insulator, and for the simple reason that in a theoretically-perfect conductor the conducting capabilities have been carried to such extreme limits, that another law comes into play somewhat similarly to what is recognised as occurring when gaseous matter is subjected to extreme pressure.

An electroplating bath differs so far from a cell constructed with two platina plates separated from one another by water, or other electrolytic liquid, that it cannot be properly regarded as a Leyden arrangement. The water of the platina plate cell when a current is passing becomes decomposed, oxygen being deposited in a condensed and very active form on the plate connected with the + pole of the circuit, and hydrogen being deposited in a condensed form on the platina plate joined to the − pole, the oxygenized plate becomes statically charged with − electricity and the hydrogenized plate receives a + charge. The quantity

of oxygen and hydrogen deposited and retained on the surfaces of the platina plates is a measure of the statical charge and energy accumulated.

In an electroplating bath there is *theoretically** neither a storage of energy, nor an accumulation of statical charge; what takes place is simply a transference of the copper on the one side of the bath to that of the other. Carrying the copper across involves an expenditure of energy which becomes dissipated and lost in the form of heat, but that is theoretically all the work done in a plating bath. A storage battery or accumulator differs from a plating bath in the fact that energy is stored up.

When an accumulator is being charged, existing structures are broken and altogether new ones raised; the new structures built up of the broken down matter are very loosely put together, and they are therefore in a condition of unstable equilibrium, and ready to fall to pieces and to give back the energy absorbed in their construction.

It is an axiom with electricians that whenever a difference of potential exists in a conductor an electric current is produced. The same thing may be expressed by saying electrical motion in a conductor involves a difference of potential, and this difference of potential is necessarily greatest at the two extremities.

Assume a given quantity of electricity is passing through a conductor whose section = 1, and that the difference of potential at the extremities = 10, double the section the difference of potential will be reduced to 5, increase the section ten times the difference of potential will be reduced to 1, increase the section of the conductor infinitely the difference of potential will now become infinitely reduced; in other words, there will be no difference of potential in the conductor. Electrical motion involves an expenditure of energy, but as the energy will be diffused over infinity there will be none available to set up electrical motion, and consequently a conductor of infinite section would be an insulator. This is, the writer considers to be, a fair logical deduction from recognised premises, it affords an illustration of how extremes meet, and may be regarded, in sort, as the electrical analogue of a theoretical point which is defined geometrically as having neither parts nor magnitude, or of the mental conception that there is no so such thing as motion in relation to absolute space.

(*To be concluded.*)

NOTES.

The Gas Supply at Brighton.—Widespread dissatisfaction prevails at Brighton owing to the inferior illuminating power of the gas supplied by the local company. An intimation from the gas company of their intention to further decrease the price of gas by 2d. per 1,000 cubic feet afforded the Corporation gas committee an opportunity of drawing attention to the fact that, with one exception—namely, Plymouth—the gas supplied in Brighton is of a lower illuminating power than that of any other leading provincial town. They recommended that the company should be asked to increase the illuminating power of their gas from 14 to 16 C.P. without increasing the price. It was estimated that this change would cost the company £3,864. In the course of a discussion which followed the opinion was expressed that the time was rapidly approaching when the Corporation would have to light their streets with the electric light. The committee's recommendation was adopted.

The Lighting of Dover.—The Corporation will apply for provisional orders.

* In practise polarisation, which is a storage of energy, does occur more or less in plating baths, and, as is well known, with inconvenient consequences at times.

Electric Lighting at Hove.—The Hove Commissioners have authorised the electric light sub-committee to advise and instruct the town clerk and solicitor in carrying through the provisional order and to approve and settle with him the necessary documents. It is understood that the proceedings for the provisional order are advancing favourably, and the committee hope soon to submit a scheme for the carrying out of the project for the board's approval.

Proposed Electric Lighting at Cowes.—The West Cowes Local Board has declined to support the application of an electric lighting company for a provisional order enabling them to light the town by electricity.

Electric Lighting Students.—If we may judge from a provincial report, professors in technical institutes will have a busy time this winter with pupils who enter electrical engineering classes. Principal Jamieson, of the Glasgow and West of Scotland Technical College, has started with 85 students in his lecture class upon electric lighting, and this number will probably be soon increased to 100. The success of Mr. Alex. W. Stewart, whose career we notice in another column, has, no doubt, acted as an incentive to many others.

Alnwick Castle and the Electric Light.—This famous building is now supplied with electric light from the Alnwick Abbey Mills.

The Lighting of the Albert Institute, Dundee.—The preliminary trials of the electric lighting in the Albert Institute were very successfully tested last week in the presence of Mr. Bryson, consulting engineer, and Mr. W. C. Martin, of Paterson & Cooper, the contracting engineers, &c. After darkness set in the lighting proved a magnificient success both in the Art Galleries and the Libraries, every part of the machinery working with perfect regularity and smoothness. The arc lamps, which are of the Phœnix type of 2,000 candle-power each, gave a brilliant light without the slightest hissing or jumping. The installation includes 1 25-H.P. Robey compound engine, 1 25-H.P. locomotive boiler, 2 Phœnix dynamos, 36 arc lamps (Phœnix), and about 200 incandescent lamps of from 16 C.P. to 50 C.P. The consulting engineer expressed his satisfaction with everything, and complimented the contractors on their superior workmanship, which was also confirmed by the other gentlemen present. The engine and dynamos were under the charge of Mr. Richardson, junr., representative of Messrs. Robey and Co., and Mr. John Hunter for the electrical department, who have discharged their duties throughout in a most efficient manner.

Paddington Electric Lighting Committee—Resignation of Mr. Judge.—At the ordinary meeting of the Paddington Vestry, held on Tuesday last in the Vestry Hall, Harrow Road, the Rev. Walter Abbott in the chair, the resignation of Mr. Mark H. Judge as a member of the electric lighting committee came up for consideration. The Vestry Clerk (Mr. Frank Dethridge), stated that he had received a letter from Mr. Judge as follows:—"After the time and attention which I have devoted to the question, I should have thought that the electric lighting committee appointed by the vestry on my motion would have elected me as their chairman. They have, however, elected Colonel Barchard to that position. I therefore beg to tender my resignation as a member of that committee." Col. Barchard said the committee was not likely to sit much longer, and therefore if the vestry intended to appoint a gentleman in the place of Mr. Judge, it was very desirable that they should do so at once. If they deferred the matter for a fortnight, the chances were that the committee would have completed their labours. Mr. Rayner observed that that being the case, he should propose Mr. Whur as a member of the committee, and this gentleman was accordingly declared elected in the place of Mr. Judge.

Electric Lighting at Pontardawe. — Mr. Arthur Gilbertson, of Pontardawe, who has just had an electric light installation fitted up, for the lighting of his tinplate works, his residence, All Saints' Church, and the reading-room for his *employés*, hopes to save £150 a year by the substitution of electric lighting for gas, which he has obtained, hitherto, from his own gas works. The installation at Pontardawe has been carried out by Messrs. Paterson and Cooper, through their local agent, Mr. John Legg, of Nelson Street, Swansea. Five or six years ago they fixed an installation for Madame Patti, at Craig-y-nos, and there has not, since then, been a single break-down or hitch of any kind. The plant at Pontardawe consists of a 16 horse-power nominal high pressure steam engine, which is worked at a pressure of 90 lbs. per square inch. The engine and boiler, when worked to their full power, are capable of giving 50 indicated horse-power. The dynamos of Messrs. Paterson and Cooper's well-known Phœnix type are two in number, and are belted direct to the engine. The pressure for the house, which is nearly a mile distant, is 125 volts, while for the works the pressure is only 65 volts. There are 116 incandescent lamps, and 14 arc lamps in the works, with the result that there is now an excellent light in every corner of the building. The mills are lit by 1,000 candle-power arc lamps, one lamp between each two mills. Each mill has, in addition, two incandescent lamps for the shears at the back of the rolls. The cold rolls are lit by incandescent lamps, one to each pair of rolls. The tin house is remarkably well illumined by two 1,000 candle-power arc lamps, and in addition to these each stack has two 16 candle incandescents. The sorting houses generally have arc lamps with incandescent lamps over the benches. The annealing and pickling houses are lit by 600 candle-power arc lamps. The stores, offices, smithy, and fitting shops, are all fitted with incandescent lights, and the sidings at night are illuminated by 1,000 candle arc lamps. All Saints, Pontardawe, is, we believe, the only church in Wales lit by electricity. The present mode of lighting inaugurates a very great improvement, and the effect is admirable. The arrangements here, like those at the works, are perfect. Thirty 32-candle-power lamps, and 11 16-candle-power lamps, have been fixed to the old gas fittings, but the wires are throughout carefully concealed. At Mr. Gilbertson's private residence, Glanrhyd, there are about 90 lamps fitted in the house, stables, and laundry, and he is well pleased with his experiment.

Lighting of the Washington Navy Yard.—An electric plant is to be installed by the Cleveland Brush Company.

The American Navy and the Electric Light.—The new steel cruiser *Philadelphia*, recently launched, will have two electric light plants of the most approved pattern, and the most compact system adapted to marine work.

The Electric Light at a Mayor's Ball.—A brilliant scene was presented in the spacious assembly room of the Esplanade Hotel, Southsea, on Tuesday night, when the Mayor and Mayoress of Portsmouth (Mr. and Mrs. G. Ellis) entertained a company numbering upwards of 600 at a grand ball. The ball-room, supper room, and contiguous apartments were illuminated by the electric light. It was a common remark among the guests that the spectacle would give an impetus to the electric lighting company which has been established in Portsmouth, and whose promoters have taken shares to the value of close upon £20,000.

Electric Lighting at Stonehouse.—The consideration of a draft provisional order received from the Devon and Cornwall Electric Supply Company, came before the Stonehouse Local Board at their last meeting. After some discussion, it was ultimately decided to adjourn the matter in order to obtain the surveyor's opinion on it.

Electric Lighting at Exeter.—The movement in favour of the electric light is making satisfactory progress in the city of Exeter. It has now been decided to light the Albert Memorial Museum by means of the new illuminant. It is hoped that other public buildings will soon follow suit.

The Bradford Installation.—The electric lighting station has not yet been handed over to the Corporation, but it is said that orders have been received for four times the lighting capacity of the present plant.

Electric Lighting in Kensington. — After certain alterations in the notice of the Kensington and Knightsbridge Electric Lighting Company for the lighting of Kensington, the committee of the County Council recommend its approval.

The Lighting of Southtown and Gorleston.—A correspondent in the *Eastern Daily Press* complains of the high price of gas in that district, which is 5s. per 1,000 cubic feet, and concludes by expressing the hope that the price may be reduced, or the electric light adopted.

Harrogate.—The Council have refused consent to private electric lighting companies. There were the usual remarks about the infancy of electric light.

Electrical Trades Union.—The following has been sent to us with a request for its insertion in the REVIEW. We have not the slightest objection to this course, and we hope that the men's social position may be advanced thereby; but to gain the support they are desirous of securing they must endeavour to behave like reasonable beings, and not exercise an attitude towards those whose opinions may differ from their own, amounting to intimidation. While fully recognising the rights and just demands of workmen, we would call their serious attention to our leading article of last week in the hope that a better feeling towards their employers may be engendered :—"To all *employés* of electric light, telegraph and telephone.—A monster meeting will be held at the Albion Hall, London Wall, Moorgate Street, on Saturday, 26th October, 1889, at 7.30 p.m., to enroll all members wishing to join our union, also to transact any business which may be brought forward. All concerned are earnestly requested to attend."

Late Communications.—We have received, but too late for insertion this week, an important letter based upon our article on "The efficiency of transformers" and Mr. Hammond's communication on the high consumption of fuel at Brighton.

High Tension Current Transmission.—Major Waller should fight shy of trying to be scientific. In a letter to a contemporary he says, in speaking of some electric lighting experiments between Deptford and London :—"It is also now demonstrated that current can be transmitted without loss of E.M.F., for, notwithstanding five transformations, the E.M.F. of the working tension at Deptford was the same as at these premises." Major Waller has demonstrated nothing but what was well known years ago, and, as our contemporary puts it, his proof would equally well show that current can be transmitted with an actual gain which may amount to thousands of volts. We would like to know whether the cable used between London and Deptford is similar to that illustrated in the *Pall Mall Gazette* of Wednesday ?

Birmingham Exhibition.—It is announced that this exhibition will close on the 31st of the present month.

New Catalogue.—Messrs. Winfields, Limited, wish us to inform our readers that they have just brought out a most comprehensive catalogue of new and original designs in electric light fittings. It would have been more satisfactory to us if the firm had sent a specimen copy for our own edification.

The Greatest Electric Railway in the World.—According to the Vienna *Zeitschrift für Elektrotechnik*, the City of Budapest boasts of possessing the greatest electric tramway. It was recently built by Messrs. Siemens and Halske, and is worked by their system of underground conductors. Three steam engines and three dynamos, each of 100 horse-power capacity, supply the current to this extensive network of rails.

Wood Mouldings for Electric Light Leads.—The patent mouldings of Mr. Samuel Elliott, of Newbury, were awarded a silver medal at the Paris Exhibition. Electrical engineers, generally, have no conception of the magnitude of Mr. Elliott's works or of the elaborate machinery he employs, and we would recommend that when any of our readers are in the neighbourhood, they should pay a visit to his establishment.

Edinburgh Electrical Exhibition, 1890.—The Lord Provost, magistrates and Town Council of Glasgow were waited on, on October 10th, by a deputation from the executive council of the exhibition, consisting of Bailie Walcot, Councillor Robertson, Councillor Pollard, Mr. A. R. Bennett, Mr. C. H. Barclay, Mr. George E. Watson (secretary), and Mr. Lee-Bapty (general manager). Bailie Dunlop, Glasgow, introduced the deputation. Mr. Watson read a letter from Sir William Thomson expressing regret that a previous engagement prevented him from joining the deputation. Bailie Walcot and Mr. A. R. Bennett addressed the Town Council, explaining the objects and scope of the exhibition, and requesting the assistance of the Glasgow people in bringing it to a successful issue, urging that although held in Edinburgh it was in reality an exhibition for the whole of Scotland. The Lord Provost said that he might state that the magistrates had carefully considered the question of the Electrical Exhibition in Edinburgh, and regarded it as one that ought to be encouraged, and as one which was calculated to be practically useful to the whole of Scotland: and remembering the liberality with which the Town Council of Edinburgh gave subscriptions to their guarantee fund at the time when their exhibition was in progess, the magistrates were unanimous in recommending that the Town Council of Glasgow should subscribe to their guarantee fund of the exhibition for the sum of £500, the Town Council of Edinburgh having already subscribed for the sum of £1,000. He moved accordingly, and the Council agreed to the proposed guarantee unanimously.

A Mare's Nest.—In the issue of the *Echo* for the 11th inst., the following inspired note occurs:—"It is not generally known that several years ago the Engineer Department of the Postal Telegraphs was abolished, and that its highly scientific duties are now performed, to the advantage of the taxpayers, by the not very highly remunerated operatives. It is much to the credit of the Department that, although the wreckages of telegraph poles and wires caused by Monday's storm might be counted by thousands, the work of restoring communication was completed by Tuesday evening. A few years ago it would have taken a week." It is, perhaps, needless to say that so far from the Engineering Department having been abolished, it continues to flourish with increased efficiency, as the last paragraph of the note indicates.

Electricity Supply Company for Spain, Limited.—Letters of allotment have been posted.

The Exeter Electric Light Company.—A statement appeared in our issue of the 4th inst. to the effect that Mr. Herbert E. Starr had been appointed to the Exeter Electric Light Company's central station. This has given rise to the impression that Mr. Starr has been appointed chief electrician to the Exeter central station, but as a matter of fact, he has joined the company as an articled pupil. Mr. Albert W. Jones is the electrician in charge.

New York in Darkness.—The New York correspondent of the *Globe*, telegraphing on the 15th inst., says:—"Last night the principal streets of New York were in darkness, in consequence of the electric light companies having closed the currents. The action of the companies is due to a dispute existing between them and the authorities on account of the dangerous condition of the overhead wires."

Prince Bismarck and the Phonograph.—The phonograph was shown and explained to Prince Bismarck on Monday. After experiments, the Prince expressed his admiration of the wonderful instrument. Copies are to be reproduced of the Bismarck phonogram.

Death of Sir Daniel Gooch.—We announce with deep regret the decease of this gentleman. As mentioned by us previously, he has been seriously ill for some time past, which terminated in death on Tuesday last at his mansion, Clewer Park, near Windsor. He will probably be more widely known as the chairman of the Great Western Railway. Recalled to this position at a time when the finances of that company were bordering on bankruptcy, ruin was staved off, and the present most flourishing position attained. He was born at Bedlington, 1816, and studied engineering in the works of the late Robert Stevenson. At the age of 21, the position of chief locomotive engineer on the Great Western Railway was offered him and accepted. In 1858, Mr. Daniel Gooch (as he was then) entered into the scheme of joining England to America by means of cable telegraphy, and he it was who despatched the first telegraphic message across the Atlantic, after almost insurmountable difficulties had been overcome. During his absence on this expedition he was returned member of Parliament, and shortly afterwards made a baronet by Her Majesty. Sir Daniel was also chairman of the Telegraph Construction and Maintenance Company.

The Japanese Electrical Society.—This Society, which was started about two years ago, has over 1,000 members.

An Electric Coal-digger.—There is at the Paris Exhibition a coal-digger which is worked by an electromotor. By its aid a man and helper can undercut 110 tons of coal in ten hours, in a seam 6 feet thick, and the power required for this at the pit-head is a little over 2½ horse-power.

Electrical Engineering Cards.—The General Electric Company is issuing a series of cards to the trade, which it is proposed to continue weekly. Three samples which have reached us relate first to the prices of carbons, secondly, of casings for electric light wires, and the third is Mr. W. H. Preece's "Fuze Table," giving the size of various wires which will be ruptured by a given current. They seem to be very useful, and the company will send them as they appear to anyone in the trade upon receipt of an application.

Electro-Physiology and Therapeutics.—On Tuesday last the first lecture on these topics, inaugurated by the Institute of Medical Electricity, was delivered with marked success to a full class, and several of the medical men present expressed the opinion that the course promised to be of great use, and was just the thing wanted by those members of the profession who had not made the subject of electro-therapeutics their special study.

Personal.—Mr Walter T. Glover, of the well-known London and Manchester wire-covering firm, left for New York on Saturday last in the steamship *Umbria*.

Mr. W. P. James Faucus, of Chester, electrical engineer, has been appointed manager of the Manchester Edison-Swan Company, Limited.

We hear that Mr. J. E. H. Gordon is no longer engineer to the Metropolitan Electric Supply Company.

Electric Launches in Spain.—*Industries* considers there is an opening in Spain for electric launches, not only on the large rivers, but also in the bays of Cadiz, Corunna, &c. A large company taking the whole matter in hand would be likely to succeed in Spain, if they made their own accumulators.

Ancient Ideas of the Telegraph.—The Rev. Canon Jackson, of Leigh Delamere, Chippenham, in a letter to the *Bath Chronicle*, says that Joseph Glanvill, rector of Bath from 1666 to 1672, in one of his treatises called "The Vanity of Dogmatising," seems to have anticipated the electric telegraph. He speaks of a couple of needles equally touched by the same magnet being set in two dials exactly proportioned to each other and circumscribed by letters of the alphabet may be made the means of communication.—It is, perhaps, unnecessary to state that this information is not new. as it is given in more than one text-book of electricity.

Incandescent Lamp Patents in America.—A New York cablegram says :—Mr. Edison won a great victory when Justice Bradley, of the United States Supreme Court, handed down the opinion dismissing the famous electrician's suit, which was practically Westinghouse against Edison—a suit running two years—to restrain Edison using fibrous carbon in his incandescent lamp. Justice Bradley says the vital question is whether the Sawyer-Mann patent is a valid claim to the exclusive use of the fibrous or textile substance for incandescent arc lights, and he decides against their claim in every particular.

Tenders Wanted.—The South Hornsey Local Board invite tenders for the construction and maintenance for seven years of street fire alarms posts, and connecting the same electrically with fire stations.

The Municipal Commissioner for the City of Bombay will, on November 9th, receive tenders for the experimental lighting of certain streets. Particulars of both tenders will be found in our advertisement columns.

Another Death.—A lineman was killed in New York last Friday while attending to an overhead electric light wire. No one could reach the man for an hour, during which time the body was slowly burnt.

New Books.—Some important new works have just been issued, prominent among them an exceedingly good "Dictionary of Electrical Words, Terms, and Phrases," by Prof. E. J. Houston, A.M.; a new and greatly enlarged edition of the "Law of Electric Lighting," by Messrs. Bower and Webb; and an interesting and well illustrated little book on magnetism (Part I.), by Prof. Andrew Jamieson, C.E. A list of the new works may be found on page 6 of our supplement.

A Strange Dispute.—The opening of the new telephone line between Budapest and Prague led to so much disputing as to the language which should be used by the *employées*, that it has been decided to use French. By this means alone could the rival claims of Czechs and Magyars, Germans and Poles, be satisfied.

Extension of the Pioneer Electric Railway.—The Lichterfelde Electric Railway, which was built by Messrs. Siemens and Halske, of Berlin, and opened on the 12th of May, 1881, has proved an entire success, and it will shortly be extended to the Potsdam Railway Station, the concession therefor having been granted at a recent meeting of the town council. The most complete description that was ever published on this railway, as regards technical details and working costs, was undoubtedly that of Mr. A. Reckenzaun, in his paper on "Electric Locomotion," before the Society of Arts, in April, 1887.

The Electrical Omnibus.—Further experiments were made with this new coach on Saturday.

The Silvertown Strike.—A letter from the Secretary of the India-Rubber, Gutta-Percha, and Telegraph Works Company, Limited, has reached us just as we go to press :—"As reports are still being circulated that we underpay our workpeople, we should be glad, with your permission, to re-state their average weekly wages and hours, viz. [Here follow the figures given in our last issue.] We also employed about 350 women and girls, who, on an average, earned 13s. 5d. for a week of 54 hours. These wages are higher than those paid by any other firm in our trade, and the directors have decided not to pay more. Hitherto the company have not engaged, or tried to engage, new hands, though a considerable number have applied for employment. The pickets who surround the factory are therefore employed in keeping out, not new men, but our former workpeople, who, so far as we are concerned, are free to return so soon as we can arrange work for them. To describe the stoppage of our works as a lock-out is therefore untruthful. It is the strike leaders who are responsible for the increasing distress in Silvertown and its neighbourhood. The directors have been asked for an interview by a few of our workpeople, and by agitators who have never been in our employment, and have made themselves conspicuous for mis-statements and abusive language. Of course the directors cannot consent to such an interview."

The Lighting of Public Vehicles.—The fact that long and dark nights are now setting in, indicating that winter is fast approaching, brings to our minds again an old grievance which periodically crops up, namely, how long must the long suffering public travel in vehicles which everybody must admit are exceedingly badly lighted. We refer particularly to the omnibuses and tramcars running in London and our provincial towns; but, of course, hansom cabs and cabs proper, or "growlers," as the latter are familiarly termed, may be placed in the same category. Already the Midland Railway Company have adopted the electric light on a few of their trains, the London, Brighton and South Coast Railway Company preceded them in the matter, and the Victoria Steamboat Association have lighted some of their steamers by electricity. Here we have the electric light by rail and by water—why should we not have it by road? that is to say, by the electric illumination of public vehicles. A year or two ago, if we remember rightly, one of the London omnibus companies did experimentally light a few of their 'buses by electricity, but nothing beyond that stage has, as far as we are aware, been done in the matter since then, and we believe that at the present moment there is not a single 'bus or tramcar electrically lighted. The adoption of the electric light in omnibuses and tramcars would confer a great boon on the travelling public, and would, if introduced gradually, not entail a very considerable initial outlay, although, of course, the larger the number of vehicles illuminated, the cheaper would be the cost in proportion. A small battery, preferably a secondary, capable of supplying sufficient current for two 12-C.P. lamps for eight hours (the maximum time of illumination during one evening), could easily be placed under an omnibus or tramcar seat. Several of the companies are sufficiently powerful, financially, to introduce electric lighting; we hope, therefore, that the initial stage inaugurated by one company in experimenting a year or two ago, will, before long, result in the development of electric lighting in the conveyances owned by that company, and that the others will go and do likewise.

Electric Lighting at Govan.—The Burgh Commissioners having had under consideration the lighting of the town by electric light have unanimously decided not to adopt it.

Fowler-Waring Cables Company.—We hear that this company has leased a portion of the old works of the late W. T. Henley at North Woolwich.

Perseverance Rewarded.—Says a writer in the Glasgow *Evening News* of the 4th inst. :—"I have to add a supplementary note to the one which I gave last week regarding electrical engineers who had studied in the Glasgow Technical College. The case that I have now to mention is one of the most interesting and successful examples of rapid progress and promotion that I know of. Mr. Alexander W. Stewart, son of the stationmaster at Dalmuir, served his apprenticeship in the naval architecture department at Clydebank Shipyard, under Mr. J. H. Biles, and gained first-class honours and the medal in the subject, as also the £5 prize given by the late Dr. J. H. Stoddart, of the *Glasgow Herald*. He then took up the study of electricity, and passed successfully through the elementary, advanced, and honours classes, taught by Prof. Jamieson, coming out first, with silver medal, at the City and Guilds of London examination in electric lighting. With such a record in his favour he was at once appointed second electrician on the Inman Liner *City of New York*, and when her sister-ship, the *City of Paris*, was floated he was made first electrician of that now famous vessel. I am told that this same gentleman has lately been offered an important position in the new shipbuilding yard of Messrs. Palmer & Co. (of Jarrow) at Bilbao—namely, that of naval architect and electrician for the works."

Underground Electric Railways.—The scheme for an underground electric railway, running north and south between Euston and the Strand, which was thrown out by a committee last year, is likely to be reintroduced in the coming session, and an effort will probably be made to combine it with the new thoroughfare decided on by the County Council.

NEW COMPANIES REGISTERED.

Electric Arms and Ammunition Company, Limited.—Capital £40,000 in £100 shares. Objects : To enter into an unregistered agreement with the American Electric Arms and Ammunition Company for acquiring certain inventions, particulars of which are not given in the registered documents. Signatories (with 1 share each) : Major C. B. Waller, Clarence Lodge, Clapham Park ; C. A. Pierce, 27, Throgmorton Street ; Col. E. Villiers, 5, Brechin Place, Gloucester Road ; James Pender, Thornley Hall, Northampton ; Capt. J. Balfour, Burcot House, Oxon ; Major J. J. Wright, 16, Carlisle Mansions ; Thos. Gommell, 45, Gloucester Street, Warwick Square. The signatories are to appoint the first directors, remuneration £100 per annum each. Registered 9th inst. by Ashurst Morris, Crisp & Co., 6, Old Jewry.

J. G. Fay and Company, Limited.—Capital £20,000 in £5 shares. Objects : To carry on business as ship, yacht, and boat, owners and builders, and as electricians, bell hangers, electro and nickel platers, &c. Signatories (with 1 share each) : J. R. Reardmore, Wm. Payne, Hy. Turpin, W. H. Rowland, J. Thomas, all of Southampton ; J. Gale, National Liberal Club ; Wm. Sharland, Winchester. The signatories are to appoint the first directors, qualification £250 in shares ; the company in general meeting will appoint remuneration. Registered 10th inst. by Robert Warner, 300, Winchester House, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Lancashire and Yorkshire Electric Lighting Company, Limited.—The annual returns for 1886, 1887, and 1888, were filed on the 5th inst., in response to a communication received by the company from the Registrar of Joint Stock Companies. The last of these is made up to the 22nd June, 1888. The nominal capital is £100,000 in 20,000 shares of £5 each. 127 shares have been taken, and £2 10s. per share has been called up, the calls paid amounting to £315, and unpaid to £2 10s. Registered office, 5, St. James's Square, Manchester.

Electrical Accumulator Association, Limited.—A meeting of this company was held on the 30th ult., when an account was laid before the shareholders as to the manner in which the winding up of the company had been conducted, and its property disposed. The notice of the meeting was duly filed on the 11th inst. The voluntary winding up of the company was agreed upon at meetings held at 17, Gracechurch Street, on the 30th of April and 15th May last.

Electricity Supply Company for Spain, Limited.—At an extraordinary general meeting of the shareholders in this company, held at 15, St. Helen's Place, on the 19th ult., it was resolved :—"That the articles of association be altered in the manner following : In article 64 the word '£1,000' shall be substituted for '£500' in line 2 thereof, and the word '£1,500' shall be substituted for the word '£1,000' in the last line thereof." The resolution was confirmed on the 4th inst., and filed on the 8th inst. The alteration increases the remuneration of the directors to £1,000 per annum, together with one-tenth of the net profit remaining after payment of 7 per cent. dividend on the ordinary shares, and provides that the whole remuneration shall not exceed £1,500 per annum.

Northampton Electric Light and Power Company, Limited.—The statutory return of this company, made up to the 27th May, was filed on the 8th inst. The nominal capital is £20,000, divided into 10 "A" and 19,990 "B" shares of £1 each. The shares taken up are 10 "A" and 1,000 "B." Upon the former the full amount has been called, and 10s. per share upon the latter. The calls paid amount to £255, and unpaid to £255. The nominal capital of the company has been increased since the return was made up to £50,000, by the addition of 30,000 "B" shares. The registered office of the company is at 2, St. Giles's Square, Northampton.

Electric Construction and Maintenance Company, Limited.—The registered office of this company, formerly at 24, Crutched Friars, is now situate at Worcester House, Walbrook.

Humboldt Electric Power and Mining Company, Limited.—The statutory return of this company is made up to the 14th March. The nominal capital is £82,500 in £1 shares. 52,500 shares are taken up and of these 27,500 are considered fully paid, and upon the remaining 25,000 shares, 7s. 6d. per share has been called. The calls paid at the date of the return amounted to £3,631 14s. and unpaid to £5,743 6s. Registered office, 63 and 64, New Broad Street.

Caddy & Co., Limited (Mechanical, Electrical and Sanitary Engineers).—The statutory return of this company is made up to the 15th March. The nominal capital is £10,000 in £1 shares, 4,000 of which are taken up, of which 3,000 are considered as fully paid, and the full amount has been paid upon the remaining 1,000 shares. Registered office, 1, Mansfield Road, Nottingham.

British Electric Tramways and General Syndicate, Limited.—The statutory return of this company is made up to the 25th April. The nominal capital is £10,000, divided into 1,850 A and 150 B shares of £5 each. At the date of the return 4 A and 85 B shares were taken up ; no call had been made upon the A shares, but the full amount had been paid upon the B shares. Registered office, 81, Gracechurch Street.

E. Page & Co., Limited (Agricultural, Electrical and Marine Engineers).—The statutory return of this company is made up to the 2nd May. The nominal capital is £30,000 in £1 shares, the whole of which has been taken up, 29,450 shares being issued as fully paid. Upon 550 shares the sum of 5s. per share has been

called, the calls paid amounting to £29,450. Registered office, the Old Corn Exchange, High Street, Bedford.

Newcastle-upon-Tyne Electric Supply Company, Limited.—The statutory return of this company is made up to the 17th of May. The nominal capital is £50,000 in £5 shares. At the date of the return 1,870 shares had been taken up and £1 per share had been called up, the calls paid amounting to £1,845, and unpaid to £25.

ELECTRIC LIGHTING WORKS IN LONDON.

LAST Tuesday, at the weekly meeting of the London County Council at the Guildhall (Sir John Lubbock in the chair), Mr. A. H. Haggis, as chairman of the Highways Committee, submitted their report, which contained the following statements and recommendations:—

"Your committee have considered the following notices, given to the Council, of works under electric lighting orders, together with reports by the engineer thereon—

"(*a*) 21st September, 1889, from the Westminster Electric Supply Corporation, Limited, of its intention to lay mains and distributing boxes in Victoria Street, Great Chapel Street, Caxton Street, and Dacre Street, as shown upon a plan sent with the notice.

"(*b*) 1st and 5th October, 1889, from the Kensington and Knightsbridge Electric Lighting Company, of its intention to lay mains and straining-up and service boxes in Wright's Lane, Cottesmore Gardens, Victoria Road, Old Brompton Road, Exhibition Road, Cromwell Road and Brompton Road, and across Queen's Gate Terrace.

"(*a*) With reference to the works referred to in the notice of the Westminster Electric Supply Corporation, the engineer has reported that the information supplied is insufficient, and that further particulars asked for have not been furnished by the company. In these circumstances your committee recommend—

"That the Council do signify its formal disapproval of the works referred to in the notice.

"(*b*) To the works referred to in the notices of the Kensington and Knightsbridge Company there appears to be no objection; and your committee recommend—

"That the Council do signify its approval of the works referred to in the two notices of the Kensington and Knightsbridge Electric Lighting Company, dated respectively 1st and 5th October, 1889, subject to the condition that the boxes to be used shall be of the same size and description as those previously sanctioned by the Council."

These recommendations of the committee were approved by the Council.

CITY NOTES, REPORTS, MEETINGS, &c.

Anglo-American Brush Electric Light Corporation, Limited (in Liquidation).

A MEETING of the shareholders of the above company was held yesterday week at the offices, Belvedere Road, Lambeth. Mr. E. Garcke occupied the chair. He stated that the object of the meeting was to settle the list of shareholders who were contributories, and to enable the liquidators to prepare and issue the certificates of the new company—the Brush Electrical Engineering Company, Limited. He might take that opportunity of informing the shareholders that the business of the new company was proceeding very satisfactorily. They were exceedingly busy with current orders. The arrangements for taking over the new works at Loughborough of the Falcon Company were completed, and they were very busy there. Those works, he might say, were fully occupied at present with business of the new company. He would be very happy to answer any questions, but unless any objection were raised by any shareholder, the list which he had prepared would be settled, and the new certificates would be made out in accordance with the list. The shareholders had all had notice of their holdings as settled in the list.

Mr. Wm. Ash said he had been connected with five or six electric light companies, some of which had entirely disappeared, and he had sustained considerable loss. He hoped that the present company would be an exception. He wished to know what was meant by par value.

The Chairman replied that it meant the nominal value of the shares. The nominal value of the old shares was £5, and as regarded the shares of the new company, the nominal value would be £2 for the preference and £3 for the ordinary shares. For every old £5 share one preference and one ordinary share in the new company would be issued in exchange. No other questions being asked, the chairman stated that the list of contributories referred to would be settled.

The meeting then terminated.

Montevideo Telephone Company.

THE report of the directors, to be presented to the shareholders at the annual general meeting to be held to-day, states that the first annual statement of accounts, made up to July 31st last, shows a profit of £10,439 15s. 10d. Off this sum there has been written £114 14s. 5d. for preliminary expenses, and £22 2s. 9d. for depreciation of furniture, leaving a balance of £10,302 18s. 8d. The directors recommend that of this amount the full dividend of 6 per cent. be paid on the preference shares, which absorbs £7,290, leaving a balance of £3,012 18s. 6d., which is applicable to a dividend on the ordinary shares. They further recommend that a dividend of 2½ per cent. be paid on the ordinary shares, that £1,000 be placed to renewal fund, and that the balance of £325 8s. 5d. be carried forward. An interim dividend on the preference shares was paid in March last. As already notified to the shareholders, it was deemed expedient to purchase in December last the business of the Montevideo branch of the River Plate Telephone and Electric Light Company, Limited, and thus consolidate the telephone interests in that city. During the year the sum of £9,646 18s. 9d. has been expended on capital account in consequence of the amalgamation of the telephonic interests now under the control of the company, and in providing the requisite plant for the most efficient telephonic service possible, such as the multiple switchboard, aerial cables, &c. In order to meet this exceptional expenditure, the directors have arranged for the issue of a portion of the unallotted capital of the company under the powers conferred upon them.

The Eastern Extension, Australasia, and China Telegraph Company, Limited.

IN the report and accounts of the directors for the half-year ended June 30th, 1889, to be submitted to the thirty-second ordinary general meeting, October 23rd, 1889:—

The usual statements of account for the half-year ended June 30th, 1889, are submitted herewith.

The gross receipts, including Government subsidies, have amounted during that period to £256,757 3s. 2d., against £239,926 0s. 5d. for the corresponding half-year of 1888.

The working and other expenses, including £22,626 1s. 8d. for cost of repairs to cables and expenses of ships, absorb £73,773 10s. 2d., against £69,297 10s. 11d. for the corresponding period of 1888, leaving a balance of £182,983 13s. From this is deducted £2,652 11s. 4d. for income tax, and £41,595 for interest on debentures and contributions to sinking funds, leaving £138,736 1s. 8d. as the net profit for the half-year, against £125,804 9s. 1d. for the corresponding period of 1888. Against this the directors have charged £50,000 on account of the Western Australian cable.

One quarterly interim dividend of 1¼ per cent., amounting to £31,250, has been paid during the half year, and another of like amount will be distributed on the 15th inst., leaving £26,236 1s. 8d. to be carried forward.

During the half-year under review the Saigon end of the Saigon-Hong-Kong cable has been partially renewed, and the cost of the operation, amounting to £8,092 11s. 7d., charged against the reserve fund. Since the 30th June a further length of 127 nautical miles has been renewed, leaving only about 14 miles to complete the renewal of the shallow water portion off Saigon. This, together with the renewal of the shallow water portion of the Hong-Kong end of the cable, will shortly be carried out.

The company's maintenance ships have, as usual, been employed on various cable repairs, but no interruptions affecting the revenue have occurred during the past six months.

The South Australian Government land line between Port Darwin and Adelaide has been well maintained during the half-year under review.

Anglo-American Telegraph Company, Limited.—At a meeting of the Board of Directors of the Anglo-American Telegraph Company, Limited, on Friday, it was resolved to declare an interim dividend for the quarter ending 30th September, 1889, of 12s. 6d. per cent. on the ordinary stock, and 25s. per cent. on the preferred stock, less income tax, payable on the 1st November to the stockholders registered on the books of the company on the 7th October, 1889.

The Direct United States Cable Company, Limited.—The Board, on Friday, resolved upon the payment of an interim dividend of 3s. 6d. per share, free of income tax, being at the rate of 3½ per cent. per annum, for the quarter ending 30th September, 1889; such dividend to be payable on and after the 24th instant.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The traffic receipts for the week ending October 11th, 1889, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,749.

The West India and Panama Telegraph Company, Limited. The estimated receipts for the half-month ended the 15th October are £2,053, as compared with £2,557 in the corresponding period of 1888.

ELECTRIC LIGHTING IN SOUTH AFRICA.

THE writer of these notes having been resident for several years in South Africa, and engaged in electrical work, has compiled the following particulars (which may be of interest to readers of the journal) of electric lighting from the time it was introduced up to the present, showing that the spirit of progress and desire to march with the times has not been altogether wanting in this colony, although it is only of late years that its claims have been generally recognised.

In 1882, when a great depression in trade was commencing all over the colony, the late South African Brush Company erected installations at Cape Town, Kimberley, and Port Elizabeth, for the purpose of demonstrating the advantages of the new illuminant and its applicability to dock and street lighting.

At these places the demonstrations were a success, and at Cape Town and Kimberley the installations were sold as going concerns to the Harbour Board of the one place and the Borough Council of the other, after the contracts had expired. Mr. J. M. Smith was appointed electrician to the Harbour Board, and under his able management the number of lamps were largely augmented, and incandescent lighting introduced in all the private houses and warehouses within the docks, so that in two years from the date of his taking office gas was entirely cut off from the main at entrance to the docks.

The following are the particulars of this installation. Arc lamps to the number of about 40 light up the docks, enabling ships to load and unload their cargoes at night time. These are of the old Brush type, newly wound solenoids being lately introduced, and which have increased the steadiness of the light in a marked degree.

Several hundred incandescent lamps illuminate the various goods sheds and private residences, and as the area to be lighted was a considerable distance from the generating station and in different directions, Mr. Smith adopted the system of having accumulators in sub-stations.

The alternating current system at this time was practically unknown, and accumulators as supplied by manufacturers were then by no means a pronounced success, so that Mr. Smith was left entirely to his own resources, and, after preliminary experiments, brought out a type of accumulator of his own design, which has lasted perfectly up to the present day, although now that accumulators as supplied by manufacturers are more reliable, he has introduced the latter for extensions, as the cost of making same only on a moderate scale is considerable. The different sets of accumulators, contrary to general custom, are placed in multiple with one another, and are perfectly self-regulating, *i.e.*, the set that has most current drawn from it takes up most of the charging current until the back E.M.F. of all are practically equal, the charging current then dividing equally between them. It is worthy of note that ever since the installation started, more than four years ago, there has not been one single breakdown, although there is only one engine at the generating station.

Mr. Smith has also under his supervision the lighting of the Houses of Parliament, the number of lights having been lately considerably increased in number to all parts of both Houses, the old Edison machine being supplemented by an Elwell-Parker of modern type, driven by a Robey engine of recent design especially made for electric lighting.

Mr. Smith has also introduced electric lighting on the Wynberg railway trains, which have been maintained without a hitch for the last 15 months, and so satisfied are the Cape Government (who own the Cape Colonial Railway) that plant has been ordered for lighting the trains from Port Elizabeth and Cape Town to Kimberley.

The lights are maintained from accumulators charged at the goods station, each of the coaches having a small set of accumulators, so that should the coaches of one train be disjoined and fixed to others the lighting is maintained, there being of course no dynamo on the train itself. Proposals are now being made by the Harbour Board for the introduction of a scheme to supply light in Cape Town, from house to house, from a large transformer station, to be erected at the Alfred Docks.

At Kimberley the public lighting of the streets has been by means of arc lamps in continual operation for the past seven years, and it is somewhat extraordinary, but nevertheless a fact, that it should be left to a town in the heart of South Africa to be the first in the world to have its streets illuminated by means of electricity without previously having any other artificial light for this purpose.

The lighting was first commenced with 16 arc lights, then increased to 32, then to 46, which are about to be still further augmented; at present they are maintained by two Brush machines, with a third one as spare. The lamps work under very trying conditions, as on account of the area over which it was desired to have them erected it necessitates working with a low current for this type of lamp, the violent dust-storms also makes it difficult for the regulating mechanism to be kept free from dust, and therefore to work freely, necessitating the constant pulling to pieces and cleaning of the same.

Lightning storms are also of frequent occurrence, and have proved to be veritable bugbears during the summer season of the year, as the insulation of the machines and wires has been most frequently impaired by its ravages.

A peculiar feature connected with these storms is, that they are accompanied by very little rain, or the latter only descends after flashes have appeared for a considerable period. The houses consist mostly of corrugated iron, making in the majority of cases good contact with the ground, a person being comparatively safe within the town. The theory propounded by some that lightning conductors prevent strokes from descending by carrying off the electricity from the clouds by silent discharge seems to the writer to be exploded, as lightning over this town, presenting as it does a large number of lightning conductors, is of the most vivid character. The lightning, by striking the aerial electric light wires, often damages the generating machinery. The writer has experimented with various forms of arresters, and found none of them to be thoroughly efficient, the lightning behaving in a most puzzling manner. The papers of Prof. Lodge and others (which have appeared lately in the technical papers) have thrown considerable light on the matter, and as the subject is of importance, in view of what has recently been written, perhaps the following notes may be of interest. In the case of a number of arc lamps being connected in series the following combination was adopted, viz.:—

The arrester on the + side was similar to that devised by Prof. Thomson, of America, consisting of two pieces of iron approaching one another to about one-eighth of an inch within an electro-magnet energised by the current of the machine. Should the current from the latter follow the lightning path the arc is repelled upwards, until the distance becomes too great for it to jump across, and therefore snaps.

The arrester on the — side of the machine consists simply of copper brushes placed $\frac{1}{8}$th of an inch apart, connected respectively to line and earth by stranded copper wires, the earth wires being attached to long-breaking switches.

1. Lightning strikes wire, ignores both arresters, runs through machine, damages insulation of same, and leaves no fault on line.

2. Same as above; leaves one fault on line by bursting through the insulation, *i.e.*, either breaking an insulator or piercing insulation of lamp-lead.

3. Same as above, but leaves two faults on the line, the machine current leaking by this path and the insulation breaking down. In one instance lamp leads laying against framework of lantern were stripped of about 2 feet of double insulation (gutta-percha and tape).

4. Same as 3, but does not break down insulation of machine, the same being short-circuited through the two earths.

5. Lightning ignores one arrester, runs through the machine and down the other, breaking down insulation.

6. Lightning strikes wire, portion runs down one arrester, remainder runs through the machine down the other, breaking down insulation.

7. Lightning strikes wire, runs through machine without damaging the same, ignoring both arresters and leaving no fault behind on line.

The following is remarkable :—

8. A small set of accumulators, which in themselves were not sufficient to reverse the polarity of the residual magnetism of the F.M's. arrester on − side of the machine, is short-circuited by a piece of copper wire, thus putting dead earth on the line. Lightning strikes the wire, ignores arrester on + side, runs through the machine down the dead earth, breaking down insulation, and the magnetism of the F.M's. is *reversed*.

9. The same as above; lightning ignores the dead earth, runs through the machine and down the other arrester.

The above are, with others, examples of the apparent vagaries of lightning.

Beside the lighting of the streets of this place, incandescent lamps have been installed in the theatre and other buildings by private individuals, with special permission from the borough authorities to cross streets at defined places. The Town Council, similar to several kindred bodies in England, have acted in a truly dog-in-the-manger kind of policy, as they have not seen their way clear to start a central station for house-to-house supply themselves, nor will they give a concession to enterprising people who are willing to find the capital to do so, excepting under very arbitrary terms, although the people desire to have the light supplied to them. Several of the mining companies have their mines and depositing floors illuminated. The Anglo-African Diamond Mining Company have three arc lamps for lighting up their washing machinery. The Bultfonten Diamond Mining Company have 23 lamps erected on their depositing floors, and six at their mine, with Bernstein incandescent lamps in series for lighting up the various engine rooms. These latter have given great satisfaction, but their life is at present rather short.

The arc lamps are of the Brush type, and have given great satisfaction, requiring very little attention; in fact, beyond an occasional inspection by the electrical engineer of Kimberly, they have no other attention excepting of course the trimming of the lamps by one of the *employés* of the company; all the above installations were erected by the borough electrical engineer.

But the company which has installations of the most extensive character is the De Beer's Consolidated Mines, Limited, the Premier Diamond Mining Company, which has arc lamps erected all over the depositing floors which cover an area of several acres of ground. These are maintained by Brush and Elwell-Parker machines, under the superintendence of their able electrician, Mr. R. O. G. Drummond, who has also introduced incandescent lamps in all the underground workings. Considerable difficulties were encountered in this latter installation, not only from sulphurous water, which leaks through the reef (that portion of the ground which is unproductive in diamonds), which gradually eats through metals it comes in contact with, but also from the native labourers who seem imbued with the idea, that everything in the shape of a lamp or wire must be meddled and interfered with.

The following, from a local newspaper, is a detailed description of this very interesting installation :—

"By the kind permission of the general manager (Mr. Gardner F. Williams), we had recently an opportunity of inspecting the intricate passages and chambers of the De Beer's Mine, which are now lighted by electricity. The requisite installation was successfully completed by. Mr. R. Oliver G. Drummond, and to him we are indebted for the explanation of the details of the plant, from the engine house and dynamos to the lamps, 700 feet below the surface. The engine is a 10-horse Fowler, of a compound condensing type, and worked at a pressure of 130 lbs. During the first trial the engine worked 27 hours without stoppage; since then upwards of 150 consecutive hours each week, as the lamps are lighted from Sunday night to the following Sunday morning. The dynamo, which is known in the market as the "Manchester," is made by Mather and Platt, of Salford. In the dynamo room are ampère and voltmeters, switchboards, cut-outs, and test lamps, by which the current can be regulated as may be needed.

"We were next taken to the shaft, and we steadily descended to the first level, 380 feet deep. We could look downwards or upwards for 300 feet, as the whole of the ladder way is lighted by lamps fixed at about 100 feet apart. These lamps are fixed in lanterns made out of four-way 3-inch water pipe. Three of the open ends are thoroughly secured by interlaced wire. and the joints soldered, where they interesect each other. The fourth end is furnished with a nipple and flange, by which it is fixed to its position, and through which the wires pass to the lamp. Although much of the light is obscured by the solidity of this screen, Mr. Drummond said no other method appeared adequate to frustrate deliberate violence to which, his experience had taught him, Kafir boys were capable of resorting, to destroy the lamp and extinguish the light. Returning to the shaft and resuming our position in the box, the electric signal was given to the engine driver and we quietly descended to the 500 feet level, which is quite dry and even, so that we could walk through the tunnel without the slightest hesitation, as the light is quite sufficient without being dazzling. At the next level, which is 600 feet deep, the light was enough to give us confidence and to prevent us from getting in the way of any impediments. The lamps are fixed to the sets in the roof, and are built into wooden shades or reflectors of a level shape. The hole where the wires lead to the lamp, is filled in with Chatterton's compound, and is then covered with a clump of wood, making the whole perfectly water-tight, and protecting the wires and metallic stem of the lamp. To the face of this shade is screwed a globe of interwoven wire, the meshes of which are five-eighths of an inch in diameter, and as each intersection of wire is soldered, the protection is very strong, and quite sufficient to defeat any ordinary effort of even a malignant person to do damage. These reflectors and wire protectors as well as the four-way lanterns in the ladder-way, have been made in the electrical workshop, under the personal superintendence of Mr. Drummond, and have so far perfectly answered the ends in view. Retracing our steps to the shaft, we descended 100 feet deeper, to the lowest level, where the chamber is well lighted by incandescent lamps.

"The main cables from the dynamos are 1⅛th of an inch in diameter and consist of wire perfectly insulated with the best solid India-rubber, which is protected by an outer covering or sheath of tarred hemp braided. The cables and all the leads are perfectly protected by substantial wooden boxes, and are fixed in their positions by wooden cleats, so that the risk of short circuit is reduced to a minimum. Nevertheless automatic cut-outs are fixed where every important lead branches off, so that if by accident a fault occurs in any portion of the circuit, the current is immediately broken, and no risk from over-heated wires can occur. The insulation is carefully tested at short and fixed periods with the galvanometer. No naked paraffin lamps or candles are used in any part of the mine which is timbered. We were very much struck with the comparative purity and coolness of the air, and even at the 700 level felt a current of fresh air circulating around us. There are about 80 incandescent lamps used in these underground workings. We are proud that De Beer's has achieved such an advance in the safety and comfort of her mining operations, and congratulate Mr. Drummond upon the able manner with which he has overcome the difficulties of the undertaking, and has carried out the details of the work."

It is also the intention of the company to apply

motors for working their system of mechanical haulage and other purposes.

It may not be out of place also to state that the tramcars of Messrs. Gibson Bros., which run between Kimberley and its suburb Beaconsfield, are about to be driven and lighted by means of the accumulator system.

Already a set of plant from Messrs. Mather and Platt, of Manchester, has been completed to order for this purpose.

Besides the above installations in Kimberley and its suburbs, there are small sets of plant at Port Elizabeth and D'Urban, used at the former place for special occasions only, and at the latter for lighting the Town Hall.

Several of the gold companies in the Transvaal have plants for lighting and transmission of power, and a powerful company has just been floated to light up Johannesberg, its suburbs, and the mines in the vicinity, taking over a concession given by the Government for this purpose, called the Johannesberg Electricity Supply Company.

This company will erect a large supply station, which is, in fact, to be the largest of its kind, in the country, capable of maintaining at the outset several thousand incandescent lamps and a number of arc lamps. It is evidently floated on the right basis, as £100,000 out of a capital of £125,000 is devoted for plant, land and buildings, and working expenses of a central station at the above place; and whereas a company in 1882 was floated with a practical working capital of only £25,000 for lighting up the whole of South Africa, in 1889 a company is floated with an available working capital of £100,000 for lighting up one town only.

Since writing the above notes the borough council of Kimberley have seen the wisdom of supplying a house-to-house service themselves, and have sent orders home for plant for this purpose and also for increasing the number of street lamps.

Mr. David Bremner has been appointed borough electrician of Kimberley, Mr. R. Lewis Cousens having resigned to take up the lighting of Johannesberg.

ELECTRICITY IN MEXICO.

ELECTRICITY, we are pleased to observe, is making remarkable progress in Mexico. Two Mexican electrical engineers, Messrs. Rafael R. Arizpe and Alberto Best, were sent by Mexico as delegates to the Paris Exhibition and to the recent International Congress of Electricians. One of them, M. Best, has just collected together the principal applications of electricity made in the Mexican Republic in a pamphlet, of which the following is a summary:

For some years, says M. Best, the electric light has been utilised in 12 of the principal towns and many others are engaged in effecting the same reform in their lighting. There are, besides, at present more than 40 electrical installations destined for the lighting of factories, mills, railway stations, theatres, &c., without reckoning many others which are under study and which are in course of execution. The above-mentioned installations for lighting, daily employ 1,368 horse-power, 162 of which are due to hydraulic force and which supply motive power for 96 electrical machines spread over 66 installations. There are 1,055 arc lamps producing a light of 2,112,000 candles and 4,796 incandescent lamps, showing 60,816 candles.

The Federal Telegraph Department is wonderfully prosperous, for the Republic has a well constructed and organised line in full work. This line has an extent of more than 44,500 kilomètres, without counting the telephonic service, which comprises 8,000 kilomètres, 470 of which are established according to the Van Rysselberghe system.

The use of electricity in medicine has been received with great enthusiasm, and there are several practices directed by clever medical men in which electricity is made use of as a therapeutic agent with remarkable success. Electrotyping and other electrical applications spread from day-to-day. Electro-technical instruction has become the object of effective protection by the Government, which, convinced of the necessity of electrical studies, spares no means of making them popular.

Before terminating this short review, giving an idea of the advancement of electricity in Mexico, M. Best cites, besides the fine installation for the lighting of the city of Puebla, whence power is also transported to a distance of 15 kilomètres, that of the public lighting of the city of Mexico. An artificial fall of water, 14 kilomètres distant from the town of Puebla, on the River Atoyac, has a power of about 2,500 horses during the rainy season and a minimum of 600 in the dry season. 110 horse-power works a Leffel turbine, which puts in movement three Houston dynamos of 6·8 ampères and 2,200 volts. Each dynamo can feed 50 arc lamps of 1,200 candles; but they are only made to supply 100 lamps, distributed in three separate circuits and which light a part of the town of Puebla. This important transport of about 100 horse-power to a distance of 14 kilomètres is carried out at a loss of 16 per cent. in the electric yield; the complete circuit is 28 kilomètres in length and the diameter of the copper conductor is 3·5 millimètres. The machine room has been specially constructed for this installation; it is very suitable for its purpose and fitted up with care.

The company which is working this business is at present making experiments with Julien accumulators, with a view to distributing motive power and light to private houses. To the west of the city of Mexico a grand station for the public lighting of the city of Mexico is being completed. The building for this purpose contains, besides the machine room which is 50 mètres long by 25 wide, offices, storehouses for materials and rooms for the engineer and employés, the whole being perfectly lighted and well ventilated. Three steam engines, producing about 1,000 horse-power, work 12 Brush dynamos.

ON THE PRESENT STATE OF TRACTION BY STORAGE BATTERIES.*

By Dr. LOUIS BELL.

THE possibility of profitably employing storage batteries for electric traction has been a most alluring one, and during the last ten years experiments have been continually in progress toward that end. Most of these experiments have been, for obvious reasons, private, and but few definite results have ever reached the public. Reports, indeed, have been tolerably numerous of late, but in most cases all details that could possibly give a basis for an estimate of the value of the system have been omitted. Every one now knows that a car can be propelled at a good rate of speed and up reasonable grades by means of a storage battery, but the questions to be answered are:—What is the first cost and probable yearly depreciation of the batteries? What is the efficiency of the system? What is the probable cost of operation compared with horses, cables, and other electrical systems?

These questions, perhaps, cannot now be fairly answered, but some recent publications give data far more valuable than anything previous; and a discussion of the general state of the problem at present is not untimely.

First, as to the efficiency of the system. It is clear from the start that the double transformation involved in the storage battery must involve a more or less serious loss of energy. The amount of this loss is easily measured in a given case; but, unfortunately, it is far from being a constant. On the contrary, it is an exasperatingly variable function of the charge and dis-

* New York *Electrical World*.

charge rates and other minor factors. The main losses in a storage battery are due to heating, local action and electrolysis of solution, and these can never be eliminated and may be greatly increased by improper treatment of the cells.

Tested in the laboratory, at low charge and discharge rates, an efficiency of 85 to 90 per cent. is quite obtainable from most modern types of cell. But a heavy discharge rate greatly lowers the efficiency, and not only does this, but is very liable to injure the cell permanently. The same cell which gave 90 per cent. efficiency at a low discharge rate may give but 50 or 60 per cent. when discharged rapidly. There are no data available to show the efficiency of a storage battery under anywhere nearly the same conditions that exist in electric traction.

The experiments which have been made with rather heavy discharge rates seem to point to from 60 to 70 per cent. as the greatest efficiency that can be expected. But these experiments do not represent the case. In street car practice the discharge rate must be of the most variable kind, and the efficiency of a storage battery under a widely varying discharge rate has never to my knowledge been determined. It would not be sufficient to determine the amount of variation and then deduce a result from experiments at a constant discharge rate, for the effect of a heavy discharge will vary as the battery is freshly charged or partially run down.

Experiments on this subject are greatly needed. As to the efficiency of the other portions of the electrical plant information is easy to obtain.

The engine used for charging the batteries can be used rather more economically than in the electrical systems using direct supply, for it can be run, even if not under constant load, at least under one not subject to sudden and great variations.

The efficiency of the dynamo being the same in either case, and taking the friction of the engine at 10 per cent. of its rated full load, an estimate in accordance with good modern practice, the efficiency from steam to electricity at the charging station might be fairly taken at 75 per cent.

$$\frac{\text{E.H.P.}}{\text{I.H.P.}} = \cdot 75.$$

The efficiency of the motors should be very nearly the same in either storage or direct systems, and for the motors in general use, the commercial efficiency, including friction of gearing, may perhaps be taken at 75 per cent., this figure being subject to so many varying conditions as to be rather uncertain.

Regarding the efficiency of the accumulators, I have shown that an accurate estimate cannot at present be made. At best it is very uncertain, but under the rather severe conditions imposed by traction work, I should much dislike to rely on a working efficiency greater than 70 per cent. from any accumulator with which I am acquainted.

We are now in a position to form a rough estimate of the probable efficiency of the storage battery system from indicated horse-power at the engine to wheel horse-power at the cars. Taking the above estimates, it will be : $\frac{\text{W.H.P.}}{\text{I.H.P.}} = \cdot 75 \times \cdot 75 \times \cdot 70 = 40$ per cent. approximately.

Comparing this figure with the direct supply systems, I find that Mr. G. W. Mansfield, in his recent admirable paper, agrees substantially with my own estimate of the obtainable working efficiency in this case, placing it at a little under 50 per cent. for ordinary cases.

If this comparison seems unfair to the storage battery, I can only reply that I am a believer in the ultimate success of the accumulator, and would hail with joy any authentic tests disproving the above estimate.

But there is yet another side to the efficiency question that deserves careful attention. In the storage system extra power must be furnished to drag around the nearly two tons of battery. In other words, the proportion of the power furnished which goes to doing useful work is much diminished.

In fact, with any system of motors whatever, it becomes necessary, if an idea of its real efficiency is to be obtained, to take into account the effect of its dead weight on the amount of power to be furnished. There may often be good economy in sacrificing theoretical efficiency to gain practical efficiency.

To obtain a proper basis for the comparison of various motor systems we must then take into account the proportion of total to useful work, and to do this I have found it convenient to combine the theoretical efficiency with the ratio of useful to total work as follows :—

$$\text{Economic ratio} = \frac{\text{commercial efficiency} \times \text{useful weight}}{\text{Total weight}} = \frac{\text{E L}}{\text{W}}.$$

Writing E for the total commercial efficiency and L and W for the useful load and total weight respectively.

The above ratio gives a correct measure of the proportion of the power supplied to any motor system which is utilised in doing useful work. The reciprocal of the economic ratio will then be the amount of power that must be supplied to the system to do unit amount of useful work.

It measures the passenger-carrying power per horse-power furnished at the prime mover.

From the standpoint of the economic ratio it is possible to make a fair though necessarily approximate comparison between all sorts of motor systems, and to make this comparison on a common basis.

Now apply this say, to the comparison between an ordinary electric car, a storage battery car, a cable car and a locomotive. The total commercial efficiency should be taken as the ratio between the power generated at the prime mover and that exerted at the car wheel. The useful load should be taken in each case as the weight of the necessary car body and truck, plus the weight of a full working load of passengers. It is clear that the car should be included, being a necessary load in each case.

Take first an ordinary electric car. A 16-foot Sprague car, with two 7½ H.P. motors complete, weighs about 6,400 lbs., of which about 2,400 is in motor apparatus, and 4,000 in car. A full working load would be about 30 persons, estimated weight 4,000 lbs.

For a storage battery car I will take the figures of the new Julien car as far as possible. The car is stated to weigh, complete, 14,000 lbs., of which 3,800 is battery. The car has to be of unusual solidity, on account of the great weight of battery. It is a 16-foot car, and has the same carrying capacity as the above.

The cable cars are always run in trains, consisting of grip and motor cars, both carrying passengers ; but as the weight of the grip apparatus is negligible compared with the total weight, the system must be credited with an economic ratio equal to its efficiency, say 50 per cent.

In the case of a locomotive we may take the weight of engine at 80,000 lbs., tender (mean) 20,000 lbs., and train of, say, four ordinary coaches, Pullman and baggage car, aggregating about 90 tons. The commercial efficiency of the system is high, since we have only to deduct engine friction, amounting to about 10 per cent. probably.

These weights are only approximations, and in any special case of course the actual weights would be substituted.

They will, however, lead to a tolerably fair comparison, and will enable some conclusions to be drawn as to the nature of the variations in the economic ratio in different systems. Computing then $\frac{\text{E L}}{\text{W}}$ we have :

System.	Economic ratio $\frac{\text{E L}}{\text{W}}$	Power for unit useful work.
Direct electric ...	·385	2·62
Storage	·18	5·55
Cable	·50	2·00
Locomotive ...	·58	1·72

The economic ratio for the steam systems will increase decidedly with a heavier load, while for the electric loads it will increase, but more and more slowly as the electrical efficiency of the motors falls off. Where traffic justifies it, the use of a trailer is decidedly beneficial, evidently. The storage car seems needlessly heavy, and its economic ratio ought to be raised to ·25. The car used in Antwerp would have given an economic ratio of ·29, but it carried 1,200 lbs. less storage battery than the New York car.

From the inability of a storage battery to stand very heavy discharge rates, the weight of battery per horse-power hour stored is quite large. From the figures given by the Julien Company as to its New York cars the battery has a capacity of 35 H.P. hours, and consequently weighs 108·6 pounds per H.P. hour.

It seems at present impracticable to run a car successfully and furnish the power necessary for the exigencies of the service with less than 3,000—4,000 pounds of battery. Unless the cells are very much lightened intrinsically or made capable of standing a much higher discharge rate than at present, there seems to be little hope of reducing this battery weight to a reasonable figure.

Next, as to the life that can be reasonably expected from the cells. All sorts of figures are given, but the only ones that seem to represent the real experience gained in the practical operation of a road are those recently published from the Brussels road. According to the result of two years' running, the positive plates would have to be renewed every 200 days. The life of the negative plates would be much longer. An American report on another type of battery used in train lighting reported positive plates destroyed within a year, and very similar experience seems to have been derived from nearly all storage batteries—out of the makers' hands. Of course with expert care continually exercised better results can be obtained. This short life makes the expenses of renewal considerable, and but little comfort can be derived from the recent suggestion that the car companies would do well to reconstruct the positive plates from the disintegrated material. From a practical point of view this is about as feasible as rewinding their burnt out armatures and casting new trolley wheels out of the scraps of the old ones. No company of moderate size could profitably undertake this sort of work.

As to actual running expenses, the most complete figures are to be found in the Brussels report. The total expense for motive power, repairs, renewals, &c., was 8 cents per car mile—$4.80 per car day, the run being 60 car miles.

The cost of maintaining the batteries proved to be $2\frac{3}{4}$ cents per car mile—$1.65 per car day.

The above cost of motive power was the same as with horses, while cost of plant, royalties and other expenses brought the cost of operating with electricity considerably above that with horses. The cost of motive power, as estimated by the accumulator company was $6\frac{4}{10}$ cents per car mile as the outside limit, while their estimate of maintenance of batteries was $1\frac{1}{8}$ cents per car mile.

The estimates of the Julien Company in New York give motive power at $3.40 per car day of 75 miles. It is to be hoped that the ratio between estimate and fact is more favourable than on the other side of the Atlantic.

By comparison with the systems of direct supply, it is evident that, owing to lower efficiency, the expenses in actual power for the same service will be considerably (50 per cent. or so) larger in the storage system. That much is assured by the lower commercial efficiency and increased weight. Then we have maintenance of batteries and motors, estimated by the Julien Company at $700 per car per year, as against maintenance of lines and motors in the direct supply system. The low figure on this would certainly be far below the above figure, particularly on roads of any size.

The comparison of the storage system with horse traction is not so easy. The Brussels figures are decidedly in favour of horses after two years' thorough trial. The track on that line, however, is not good, and the grades are higher than seem advisable with the storage system, there being one grade of 4 per cent. 1,500 feet long. American figures are not sufficiently definite as to details, and the favourable results have been obtained by an accumulator company's own expert care. All that can fairly be said is that it yet remains to be proved that the storage system can be operated as cheaply as horses. So long as we have to rely on the heavy and rather perishable lead accumulator, proof will be hard to obtain.

It seems to have been demonstrated that the storage system, economy aside, may be made thoroughly reliable in careful hands. The New York cars have an enviable record in this respect.

To sum up: The storage system has certain great merits which especially commend it for city work. It requires only a track; each car is an independent unit, and no accident can cripple the system. The service can be made thoroughly reliable.

Its economy is at present doubtful; it costs distinctly more than traction by direct supply and probably more than traction by horses, unless under specially favourable circumstances.

In any electric system, carefully laid track is necessary for success; but in the storage system it is doubly so, and steep grades are peculiarly undesirable. There is nothing more likely to hasten deterioration of batteries than the jolting due to a rough track and the heavy discharge rates necessary on a steep grade. For city work, with good level tracks, it is certainly an ideal method of traction.

In closing, let me say that I feel confident that the time will come when the storage battery will be the general method of traction wherever the overhead wires are objectionable, and specially in large cities. The time is not yet, however, and it is by no means certain that any of the present types of accumulator will share in the ultimate success of the system.

DR. JOULE.

THE death of Dr. James Prescott Joule, which took place at his residence, 12, Wardle Road, Sale, at half-past 10 o'clock last Friday night, will be heard of with the deepest regret by a very wide circle indeed. Probably one of the best obituary notices of the deceased gentleman is that in the *Manchester Courier*, from which we extract the following:—

"Dr. Joule was born in New Bailey Street, Salford, on Christmas Eve, 1818, and in his early years he was a delicate child, and, as a consequence of his feeble physical condition, was not sent to school. The rudiments of learning were imparted to him by his mother's half-sister, and his education was subsequently carried on at his father's house at Broomhill, Pendlebury, by tutors, until he reached the age of 16. His first instruction in physical science was received from Dr. Dalton, who has been deservedly described as one of the most distinguished chemists of any age or country. Very early in his studies he was found at work on the molecular constitution of gases. His father allotted him a room as a laboratory, and his first effort seems to have been the construction of a cylinder electric machine of a very primitive form. The cylinder consisted of an ordinary glass tube, and the prime conductor a poker hung up by silk threads, while his Leyden jar was a bottle half filled with water, and placed in an outer vessel, also containing water. In the construction of this apparatus he had the assistance of his brother, Benjamin, who does not appear to have wandered very wide in the fields of chemistry, but who has earned for himself a lasting fame in connection with the revival of church music, and as the author of many musical and other works. The future Dr. Joule gradually enlarged the apparatus at his command, and soon entered the ranks as an investigator. His first original paper appears to have been published in 1838, when the writer was only 19 years of age, in Sturgeon's

'Annals of Electricity' for January of that year. He had constructed an electro-magnetic engine, which he described in his paper, and following up his first experiment in this subject of electro-magnetism, which was at that time a favourite theme among scientific men, he constructed other machines and electro-magnets of novel forms, with which he obtained results of great importance. These results showed the impossibility of realising the expectation which appears to have been then entertained that electro-magnetism would eventually supersede steam as an economical source of motive power. In 1840 he discovered the existence and value of the limit to the quantity of magnetisation in soft iron, and applying this principle he succeeded in constructing electro-magnets of a much greater lifting power than any which had been previously obtained, while he studied also the methods of modifying the distribution of force in the magnetic field. To stimulate experimental inquiry in electricity and magnetism, the then editor of 'Annals of Electricity' had offered a series of prizes, and one of these was awarded to Mr. Joule, with the following words of high commendation :—'Mr. Joule is one of those indefatigable and now well-disciplined experimentalists whose first essays in experimental science these "Annals" have the honour of recording. His enquiries have been directed principally to the department of electro-magnetics, in which he has been particularly successful.' In commencing his investigations into the subject of the distribution of force in the magnetic field, Dr. Joule was met, to use his own words, with 'the difficulty, if not impossibility, of understanding experiments and comparing them with one another which arises in general from incomplete descriptions of apparatus, and from the arbitrary and vague numbers which are used to characterise electric currents. Such a practice might be tolerated in the infancy of science, but in its present state of advancement greater precision and propriety are imperatively demanded.' He therefore determined to abandon the quantity numbers which he had previously used, and to express his results on the basis of a unit which should be at once scientific and convenient ; and, realising the importance of having a system of electric measurement which would make experimental results obtained at different times and under various circumstances comparable among themselves, and also perceiving the advantage of such a system dependent on, or, at any rate, comparable with, the chemical action producing the electric current, he adopted as the unit quantity of electricity the quantity required to decompose nine grains of water, nine being the atomic weight of water according to the chemical nomenclature then in use. He had previously made important improvements in the construction of galvanometers, the results of which he had made public, and he graduated his tangent galvanometer to correspond with the new system of electric measurement. Working on this basis, the numbers used in all his subsequent papers are easily reducible to the modern absolute system of electric measurements, in the construction and general introduction of which he himself played so prominent a part.

"In 1840, after experimenting on improvements in voltaic apparatus, he turned his attention to the heat evolved by metallic conductors of electricity, and in the cells of a battery during electrolysis, and by papers which he published in that and the two following years, laid the foundation of a new province in physical science, then totally unknown, but now familiar to all practical electricians, that of electric and chemical thermo-dynamics. With regard to the heat evolved by a metallic conductor carrying an electric current, he established what had previously only been supposed to be the law—namely, that 'the quantity of heat evolved by it (in a given time) is always proportional to the resistance which it presents, whatever may be the length, thickness, shape, or kind of the metallic conductor'—while he also established the law, hitherto unknown, that the heat evolved is proportional to the square of the quantity of electricity passing in a given time. Corresponding laws were established for the heat evolved by the current passing in the electrolytic cell, and likewise for the heat developed in the cells of the battery itself.

"Having proved the impossibility of applying magnetism to the generation of motive power economically, he turned his attention more especially to the transformation of chemical energy into heat, and in a communication made in 1840 to the 'Proceedings of the Royal Society' he established relations between heat and chemical affinity, which high scientific authorities have since acknowledged contained the germs of the subsequent vast development of dynamical science as applied to chemical action. In 1841 and 1842 he continued his investigations into this branch of study, and in January, 1843, was able to announce with certainty that the magneto-electric machine enables the conversion of mechanical power into heat. In the early part of this year most of his spare time would appear to have been devoted to making experiments necessary for the discovery of the laws of the development of heat by magneto-electricity, and for the definite determination of the mechanical value of heat.

"At the meeting of the British Association in Manchester in 1842—the last meeting, it may be remarked by the way, at which his teacher Dalton appeared—Dr. Joule read a paper on the 'Electric Origin of Heat,' which evoked considerable attention from the *savants* present ; and in the following year, when the Association met at Cork, he read a second paper on 'The Calorific Effects of Magneto-Electricity and the Mechanical Value of Heat,' in which he described a series of experiments in magnetic electricity, made with a view to determine the mechanical value of heat, and which had the effect of attracting still deeper attention to the subject. In this year Mr. Joule's father had removed from Pendlebury to Oakfield, Whalley Range, and there built for his son a convenient laboratory, in which his future experiments were carried on under somewhat more favourable conditions than he had previously enjoyed. In a postscript to the paper which he read at Cork Dr. Joule said : 'I shall lose no time in repeating and extending these experiments, being satisfied that the grand agents of Nature are, by the Creator's fiat, indestructible, and that wherever mechanical force is expended an exact equivalent of heat is always obtained.' He did continue the experiments, and being met with the pressing need of accurate thermometers, he produced, with the assistance of Mr. Dance, an instrument maker of this city, the first of really accurate English thermometers. Had he done no more than this he would have made an important contribution to the cause of science, and one which would have obtained for him a place on the roll of great scientists. In 1844 he communicated to the Association a paper on his continued experiments, and again, in 1845, in an important paper on 'The Mechanical Equivalent of Heat,' he detailed the results gained from water agitated by a paddle-wheel.

"In 1847 the British Association met at Oxford, and in one of the sections Mr. Joule read a fresh paper on 'The Mechanical Equivalent of Heat,' and the following extract from a letter written by Sir William Thomson to Mr. J. T. Bottomley describes the meeting of the celebrated physician with the subject of our sketch at this gathering of scientific men :—'I made Joule's acquaintance at the Oxford meeting, and it quickly ripened into a life-long friendship. I heard his paper read in the section, and felt strongly impelled at first to rise and say that it must be wrong, because the true mechanical value of heat given, suppose in warm water, must, for small differences of temperature, be proportional to the square of its quantity. I knew from Carnot that this must be true (and it is true ; only now I call it "motivity," to avoid clashing with Joule's "mechanical value.") But as I listened on and on, I saw that (though Carnot had vitally important truth, not to be abandoned) Joule had certainly a great truth and a great discovery and a most important measurement to bring forward. So, instead of rising with my objection to the meeting, I waited till it was over, and said my say to Joule himself at the end of the meeting,

This made my first introduction to him. After that I had a long talk over the whole matter at one of the conversaziones of the association, and we became fast friends from thenceforward. However, he did not tell me he was to be married in a week or so; but about a fortnight later I was walking down from Chamounix to commence the tour of Mont Blanc, and whom should I meet walking up but Joule, with a long thermometer in his hand, and a carriage with a lady in it not far off. He told me he had been married since we had parted at Oxford, and he was going to try for elevation of temperature in waterfalls. We trysted to meet a few days later at Martigny, and look at the Cascade de Sallanches, to see if it might answer. We found it too much broken into spray. His young wife, as long as she lived, took complete interest in his scientific work, and both she and he showed me the greatest kindness during my visits to them in Manchester, for our experiments on the thermal effects of fluid in motion, which we commenced a few years later.' Mr. Joule still further continued his experiments until he had secured that at which he aimed, and the truth of his theory was assured. In an elaborate paper read before the Royal Society in 1849, and published in the 'Philosophical Transactions,' we have the results of his experiments thus stated :—'The quantity of heat produced by the friction of bodies, whether solid or liquid, is always proportional to the quantity of force expended;' and secondly, 'The quantity of heat capable of increasing the temperature of a pound of water by 1° Fahr., requires for its evolution the expenditure of a mechanical force required by the fall of 772 lbs. through the space of 1 foot.'

"Prior to the successful issue of Mr. Joule's researches, the true principle of the dynamical theory of heat was not experimentally demonstrated. It is true that the idea upon which he laboured had revealed itself to several minds, and a number of investigators had contributed with more or less success to its elucidation. Among these were Faraday, Grove, and Dulong, but to Mr. Joule unquestionably belongs the honour of first demonstrating the law of mechanical equivalence between work and heat. For this achievement the Royal Medal of the Royal Society was awarded him in the year 1852. It was presented to Mr. Joule by the late Earl Rosse, who referred in high terms of appreciation to the discovery for which it was awarded, as one which united in itself a practical as well as a profound scientific interest. But prejudices are strong, and the world, even the scientific world, was slow to appreciate the value of the discovery Mr. Joule had made. Eight years after he had received the Royal Medal of the Royal Society he was called to occupy a still higher place of honour. Men of science had by this time more fully grasped the benefits accruing from his researches and experiments, and we find him the recipient of the Copley Medal of the Royal Society in 1860. It was presented to him by Sir Edward Sabine (the president), who, in handing it to Mr. Joule, referred to the honour he had previously gained, and said: 'Both awards refer to the same experiments, and are substantially for the same great step in natural philosophy. You are all aware that a great principle has been added to the sum of human knowledge—one fruitful in consequences in a thousand ways, and which, being accepted among undisputed truth, is now embodied without question alike in the most wide-ranging speculations and the most matter-of-fact practice. The award of two medals for the same researches is an exceedingly rare proceeding in our society, and rightly so. The Council have on this occasion desired to mark by it in the most emphatic manner their sense of the special and original character and high desert of Mr. Joule's discovery.' It thus appears that Mr. Joule's discovery had now taken its place among the unquestioned truths of science. But he was not to be allowed to enjoy the fulness of his honours undisturbed. There were others who claimed a share in the valuable discovery he had made, and in 1862, in a lecture delivered at the Royal Institution, Dr. Tyndal pressed the claims of Mayer (Jules Robert Mayer, a physician at Heilbron, in Germany) to a share in the honour of the discovery. He pressed these claims in a manner which aroused the objections of scientific men, particularly of Sir William (then Professor) Thomson and Prof. Tait, and a long controversy ensued. Although Dr. Tyndal advanced all he could on behalf of Mayer, he did not fail to recognise the great merits of Joule. In one of his lectures he thus spoke of him :—'It is to Mr. Joule, of Manchester, that we are almost wholly indebted for the experimental treatment of this subject. With his mind firmly fixed on a principle, and undismayed by the coolness with which his first labours appear to have been received, he persisted for years in his attempts to prove the invariability of the relation between heat and ordinary mechanical force. The results of his experiments leave no doubt upon the mind that under all circumstances the absolute amount of heat produced by a definite amount of mechanical force is fixed and invariable.' Subsequently Dr. Tyndal, addressing Dr. Joule, said, 'You worked independently of Mayer, and in a totally different way you brought the mechanical theory to the test of experiment, and in this way proved its truth.'

"But with all his knowledge he united that reverence for the great wisdom of the Creator, who is present in the minds of all the truly great. In the same lecture he adds: 'I cannot but be filled with admiration and gratitude for the wonderful provision thus made by the author of nature for the protection of His creatures.'

"The frienship formed between Joule and Thomson in 1847 grew rapidly. A voluminous correspondence was kept up between them, and several important researches were undertaken by the two friends in common. Dr. Joule was also engaged with Dr. Scoresby in an inquiry on the applications of electro-magnetism, a subject upon which Dr. Joule, as we have already shown, worked diligently in the earlier stages of his career. Among successful experimentalists in this branch of science the name of Dr. Joule takes a high place.

"We have already given evidences of Dr. Joule's inventive talent and skill, and as a further instance it may be mentioned that in 1863 he described to the Manchester Philosophical Society a new thermometer which he had constructed, and by which he was able to detect the heat radiated by the moon. When the moonbeam passed gradually across the instrument the index was deflected several degrees, first to the right and then to the left, thus showing that the air in the instrument had been heated a few thousandths of a degree by the influence of the rays.

"Valuable as are Dr. Joule's labours in other departments of inquiry, it is on his researches on the dynamics of heat, and especially on his great experimental contribution to the establishment of the law of the conservation of energy—one of the grandest generalisations of modern times—that his fame will chiefly rest.

"Though the results of his investigations are for all men and for all time, Dr. Joule was himself in no sense a public man. He undertook his studies with the determination of one who worked not for reward of position or fame, but for love of the work itself; and, unlike many of his eminent scientific contemporaries, he has neither written popular treatises nor published any separate works on the subjects of his various inquiries. He did, it is true, in addition to his papers read before various societies of learned men, occasionally deliver lectures in connection with one or other branches of his studies in this city, but these rich scientific treats were of very infrequent occurrence. Though he sought neither honour or reward for himself, honours were showered upon him in profusion, and that which was probably the greatest gratification to him was one in June, 1878, when her Majesty the Queen was pleased, in recognition of his services to the cause of science, to grant him a pension of £200 per annum. It was not for itself that he valued the pension, information of the granting of which was conveyed to him in a letter from the late Earl of Beaconsfield, but as a national recognition of his labours.

"In 1872 he was elected president of the British

Association, which in that year held its meeting at Bradford, but before the meeting his health broke down and he was unable to attend and deliver the customary inaugural address.' Since that date he was almost entirely an invalid, quietly pursuing his studies as far as his health permitted at his residence at Sale. His wife died in 1854, after only seven years of married life, leaving behind her a son and a daughter, both of whom are still living. Of Dr. Joule it may be truly said that he has passed away full of years and of honour, and that he has left behind him not only a legacy in the results of his labours, but a noble example to every one who comes after him to do with his might whatsoever his hand findeth to do."

NEW PATENTS—1889.

15377. "Improvements in electric machines or motors." C. C. PECK. Dated October 1. (*Complete.*)

15402. "Improvements in or relating to alternate current electric distribution." W. P. THOMPSON. (Communicated by G. Westinghouse, jun., United States.) Dated October 1.

15446. "Improvements in the method of and apparatus for 'forming' or charging plates for electrical accumulators." S. C. C. CURRIE. Dated October 1. (*Complete.*)

15449. "Improvements in electrical cables." W. T. GLOVER. Dated October 1.

15489. "Improvements in electricity meters." F. TEAGUE. Dated October 2. (*Complete.*)

15490. "Improvements in supports relating to telephones." T. SMITH. Dated October 2.

15509. "Improvements in electric bells." C. H. MARTIN. Dated October 3.

15524. "Improvements in electric bells." F. H. BERRY. Dated October 3.

15567. "Improvements in means for propelling vehicles by electricity." J. KINCAID, E. MANVILLE and J. E. WALLER. Dated October 4.

15643. "Improvements in rheostats or apparatus for regulating electric currents." J. A. KINGDON. Dated October 4.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1889

5014. (Under International Convention.) "Improvements in switches and in suspenders for overhead conductors in electric railways." C. J. VAN DEPOELE. Dated March 22. 8d. Relates to an improved means for suspending and supporting the current supplying conductor, or conductors, of an electric railway of the type in which the current is taken from an overhead conductor by a contact device travelling with the moving vehicle. The device embodying the principal feature of the invention is called an "arched suspender," and a prominent feature in the improvement resides in the fact that the conductor is by means thereof supported in the same transverse plane as the cross wire, and therefore cannot tilt its immediate support, whatever the desired position of the conductor, a difficulty frequently interfering seriously with the operation of a railway when equipped with downwardly extending supporting devices. 16 claims.

8855. "Improvements in secondary batteries or accumulators." T. HARRIS and H. F. DE BATHE CAMERON. Dated May 28. 6d. Claims:—1. In the manufacture of secondary batteries or accumulators, the method of fixing the active material in the apertures or interstices of the plates by screw threading or otherwise corrugating said apertures, substantially as described. 2. In a secondary battery or accumulator, the washers and rods of vulcanite or other suitable non-conducting material, when arranged to secure the elements together, substantially as described. 3. In a secondary battery or accumulator, the washers extending below the bottom of the plate to form legs to support the battery, substantially as described. 4. In a secondary battery or accumulator, the elastic cushion supporting the battery and formed of a sheet of elastic, non-conducting material, provided with the cups or bosses thereon, substantially as described.

9576. "Improvements in and relating to incandescent electric lamps." H. H. LAKE. (Communicated from abroad by S. F. Van Choate, of America.) Dated June 8. 11d. Relates to incandescent electric lamps, and is chiefly designed to improve the construction of the same. 29 claims.

11044. "Improvements in storage batteries." W. P. THOMPSON. (A communication from abroad by P. H. Alexander, of America.) Dated July 9. 6d. Claims:—1. A storage battery, consisting of two or more cells formed by similar plates, the plates forming the sides of the cells, the spaces being filled with a suitable electrolyte, whereby one side of each plate becomes positive and one side negative in the process of charging. 2. The combination of a box or case, a series of similar battery plates of width less than the interior of the case, insulating strips between the sides and lower ends of said plates, thereby forming cells between the plates, and an insulating and waterproof cement filling between the sides of the case and the edges of the plates. 3. The combination of a series of battery plates, arranged with insulating divisions between them, said divisions being made moisture tight, whereby the spaces between the plates form cells for the electrolyte, and insulating plates interspersed, whereby the battery is divided into two or more separate series.

11328. "Improved grids or supporting frames of electric accumulators." E. CORRENS. Dated July 15. 6d. Claims:—1. In electric accumulators for fixing the active material a body composed of two grids placed inversely one over the other, each having orifices situate irregularly one over the other and narrowing from the inner to the outer side, the active material filled into the orifices of both grids forming a united whole, substantially as described and shown. 2. The production of a body composed of two grids by means of a stamp or die stamping the bottom grid after passing by the upper grid, the grids being turned over to bring the shaped grid uppermost, and the second grid to be shaped to the bottom position, substantially as described and shown for the purpose specified.

11732. "Improvements in and relating to electric telegraphs." F. ANDERSON. Dated July 23. 1s. 1d. Relates chiefly particularly to improvements in that class of telegraphs known as automatic or stylographic telegraphs, and to this end it consists in an improved form of automatic telegraphic receiver. The object of this part of the invention is to produce a record upon a continuous sheet of paper in such a manner that it may be read as an ordinary paged book or paper is read, so that the record is made by a series of lines which indicate in sequence the characters transmitted, said characters being of the well known Morse or equivalent type. 22 claims.

CORRESPONDENCE.

Telephone Patents.

With reference to your correspondent's (Mr. H. M. Edwards) enquiry in your last issue as to whether he could legally use the telephone instruments now on the market, for your correspondent's information I send you the following details.

The instrument designed by me some six years (during which period it has been manufactured and sold by this company), contains no carbon or other microphone as claimed by Edison, nor permanent magnet or diaphragm capable of inductive action as claimed by Bell, the diaphragm being made of a pure animal membrane, in exact conformity with the disclaimer of William Morgan Brown (Bell's patent), and your correspondent need therefore have no fear of legal proceedings being taken against him for infringment should he use our instruments.

Electric Telephone Company.
ERNEST J. GILLETT.

October 15th, 1889.

Electric Traction.

Mr. A. J. Jarman has taken my question in a different light altogether from that intended. He is not justified in assuming that I have not read carefully the specifications concerned. As a matter of fact, I have made a special study of the various tramway systems now before the public. I would remind your correspondent that the mere fact of obtaining an English patent does not prove that the subject is new, or of any earthly use whatever. It was hardly necessary for Mr. Jarman to state that he would advise his syndicate to proceed against anyone infringing their rights, but that is no answer to the question I put to him. A fair question demands a fair answer. I cannot but suppose he is acquainted with the systems I have mentioned, and I again submit that there is no difference in placing two motors side by side, or at opposite ends of the car.

William Houghton.

Norwich, Norfolk.

[This discussion, out of which nothing can possibly come, had better end with Mr. Houghton's letter.—EDS. ELEC. REV.]